Engineering
for a better
world.

GEA.com

PRODUCT CATALOG

Ejectors, jet pumps, mixers, heaters, compressors

GEA Wiegand GmbH
Am Hardtwald 1
76275 Ettlingen, Germany

Tel +12 345 67-0
gea.com/contact

Engineering
for a better
world.

GEA.com

TABLE OF CONTENTS

GEA Engineering for a better world.

EJECTOR APPLICATION OVERVIEW

Ejectors (also called jet pumps) are versatile devices used for the conveyance, compression, or mixing of gases, vapors, liquids, or solids. They operate without moving parts, relying on a motive fluid (liquid, steam, or gas) to create a jet that entrains and accelerates another medium.

The main application areas:

Vacuum applications

- Generating vacuum
- Pre-evacuating vessels and columns
- Extracting liquid from membranes

Dosing / Diluting

- Water disinfection using ozone or chlorine
- Deacidification of drinking water
- Addition of chemical additives (e.g. in the petroleum industry)

Conveying applications

- Simultaneous conveying and dissolving of solids (e.g. limestone, activated carbon powder, sugar)

Compression applications

- Compression of gases (e.g. H_2, natural gas)
- Recirculation of gas phases in reactors with intensive contact to liquids (e.g. EDC – chlorine)
- Aeration of water (e.g. drinking water, bioenzymatic processes)

Mixing applications

- Motor oil production (mixing in additives)
- Acid blending
- Wastewater treatment
- Beer production (final product and fermentation stage)
- Fruit juice processing
- Sugar solution preparation
- Vegetable oil processing
- Biodiesel production (re-esterification, emulsion formation, bio-enzymatic processes)
- Sedimentation prevention

Heating applications

- Heating starch solutions
- Heating cleaning solutions
- Temperature control of storage tanks
- Heating water tanks using immersed pipe coils
- Frost protection for storage tanks
- Heating molasses (yeast production)
- Heating black liquor (paper industry)
- Creating vacuum
- Pre-evacuation of vessels and columns

Ventilating applications

- Extraction of large volumes of gases
- Ventilation of tanks (e.g. exhaust gases such as SO_3)
- Ventilation and condensation of gases within their own medium
- Gas recirculation for energy-optimized systems

JET PUMPS

Jet pumps, also known as ejectors, are devices used for the conveyance, compression or mixing of gases, vapors, liquids or solids in which a gaseous or liquid medium serves as the motive force. They operate by the conversion of pressure energy into velocity in suitable nozzles. They are “pumps without moving parts”.

The basic principle of jet pumps consists in the liquid or gas jet being emitted by a nozzle at high speed entraining and accelerating the surrounding liquid, gas or solid matter. The result of this action is a mixture of the driving and entrained (sucked) fluids, the velocity of which is reduced and the pressure increased in a second nozzle.

The practical application of this principle requires a simple apparatus which essentially consists of only 3 main parts (fig. 1):

- motive nozzle (1)
- diffuser (2)
- head (3)

The flow channel of the diffuser consists of a part converging in the direction of the flow (the inlet cone), a cylindrical piece (the throat) and a diverging part (the out- let cone).
The pressures at the connections and the corresponding mass flows determine the functional effect of a jet pump.
A jet pump is provided with at least 3 connections (fig. 1):

- motive medium inlet connection (A)
- suction manifold (B)
- pressure manifold (C)

The pressures prevailing there are as follows (fig. 2):

- p1 pressure upstream of the motive nozzle = motive medium pressure
- p0 pressure at the suction manifold = suction pressure
- p pressure at the outlet manifold = discharge pressure

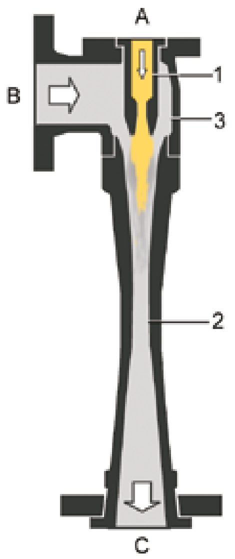


Figure 1

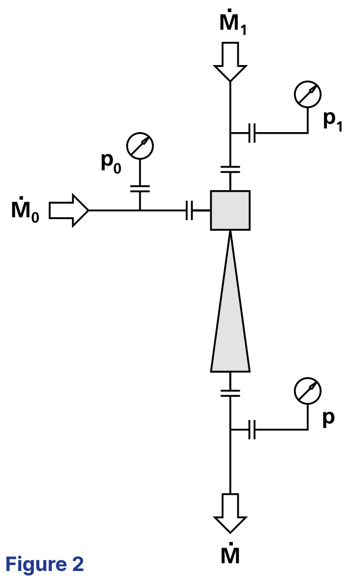


Figure 2

Designations of jet pumps
The terms of jet pumps (ejectors) are defined in DIN 24290. According to DIN 24290, jet pumps are named according to the motive side and to the suction side. The designations in this catalog follow this standard.

According to the suction side	According to the motive side		
	Gas jet pump	**Steam jet pump**	**Liquid jet pump**
Jet ventilator	Gas jet ventilator	Steam jet ventilator	Liquid jet ventilator
Jet compressor	Gas jet compressor	Steam jet compressor (vapor recompressor)	Liquid jet compressor
Jet vacuum pump	Gas jet vacuum pump	Steam jet vacuum pump	Liquid jet vacuum pump
Jet liquid pump	Gas jet liquid pump	Steam jet liquid pump	Liquid jet liquid pump
Jet solids pump	Gas jet solids pump	Steam jet solids pump	Liquid jet solids pump

The designation of the individual parts of a jet pumps is standardized according to DIN 24291.

LIQUID JET VACUUM PUMPS

Applications

Liquid jet vacuum pumps with threaded connections are mainly used in chemical laboratories for the production of vacuum, for example in vacuum distillation or drying.

They are also used for evacuating syphon lines, suction lines of circulating pumps and condensers; for deaeration of pressure vessels and for producing negative pressure in Nutsch filters.

Working principle

Liquid jet vacuum pumps, when water is used as the motive medium, can be directly coupled to the water line. If, however, the water consumption has to be as economical as possible, the operating water may be circulated. This is also the case when other liquids are used as the motive medium, instead of water.

The temperature of the operating liquid may be kept low by the constant addition of a small quantity of fresh liquid. Higher vacuum can be achieved by further cooling of the operating liquid. This is particularly expedient when the suction flow contains condensable components, e.g. solvents. In such a case the vacuum pump can be operated by using the condensate as the motive medium.

The lowest suction pressure which can be obtained with a suction capacity of zero (blind vacuum) corresponds to the vapor pressure of the motive liquid which depends on the temperature of the liquid.

The action of liquid jet pumps is based on the fact that the liquid jet coming out of the motive nozzle at high speed entrains air, gas, liquid or solid matters from the head of the jet pumps and compresses them to atmospheric pressure.


Stainless steel, with threaded connections


Stainless steel, with flanged connections

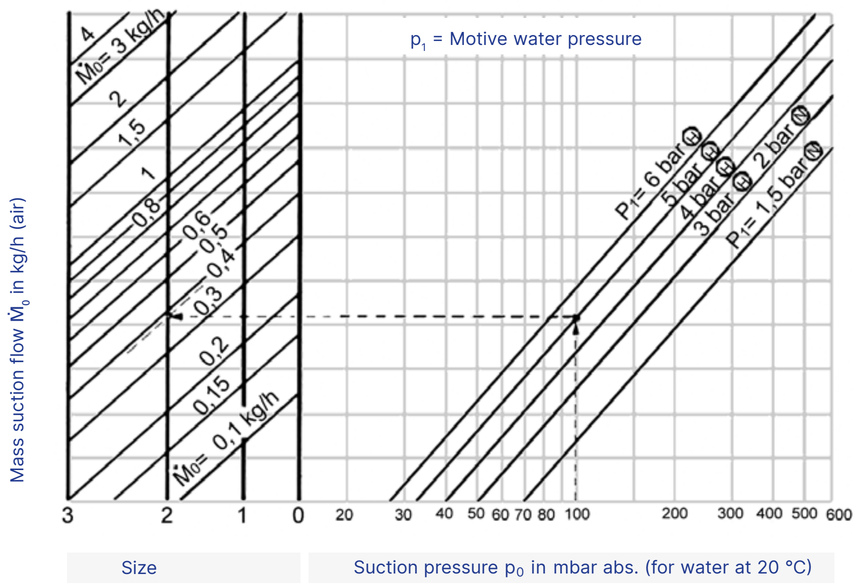

PTFE, with flanged connections

Liquid jet vacuum pump with threaded connections

Performance chart (Vacuum pump)

Diagram fig. 1 gives the mass suction flow in kg/h of air in relation to the suction pressure at various operating water pressures for 4 pump sizes. The curves are based on an operating water temperature of 20 °C. The motive liquid consumption or the motive liquid flow (circulating water operation) can be taken from diagram fig 2.

Figure 1



Ⓝ = Low pressure construction (1.5–2 bar)
Ⓗ = High pressure construction (3–6 bar)
Pressure indications in bar = bar g

Design example

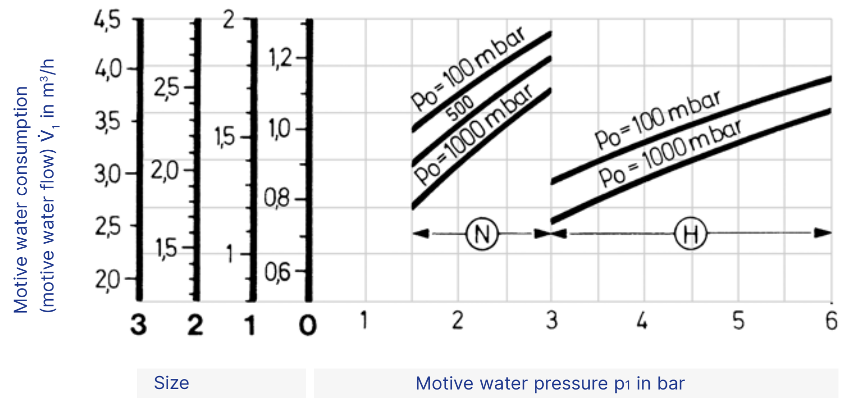
0.35 kg/h of air has to be continuously exhausted out of a plant. The suction pressure amounts to 100 mbar abs. A motive water pressure of 5 bar g is available. The motive water has a temperature of 20 °C.

Parameters to be found: Size of pump and motive water consumption.

Solution: From diagram fig. 1, for a suction pressure of 100 mbar and a motive water pressure of 5 bar g, pump size 2 with a mass suction flow of 0.38 kg/h is closest to the required suction volume.

From diagram fig. 2, for a motive water pressure of 5 bar g and a suction pressure of 100 mbar a motive water consumption of 2.35 m³/h for the chosen size 2 can be found.

Figure 2



Ⓝ = Low pressure construction (1.5–2 bar)
Ⓗ = High pressure construction (3–6 bar)
Pressure indications in bar = bar g
p_0 = Suction pressure in mbar abs.

Performance chart (Pre-evacuator)

Diagram fig. 3 gives evacuation time in minutes a liquid jet vacuum pump size 2 needs to evacuate a vessel volume of 100 l to a defined suction pressure. The selection of other sizes is achieved by the following conversion formula:

$$F = \frac{t_{spec.}}{t_{evac.}} \cdot V$$

F	Factor for the selection of the pump size
$t_{spec.}$	Specific evacuation time in min/100 l (from diagram fig. 3)
$t_{evac.}$	Expected evacuation time in minutes
V	Volume of vessel to be evacuated in liter

Size	0	1	2	3
Factor F	0.44	0.68	1	1.5

Design example

A vessel of 400 l is to be evacuated to 400 mbar in 5 minutes. The water pressure is 3 bar.

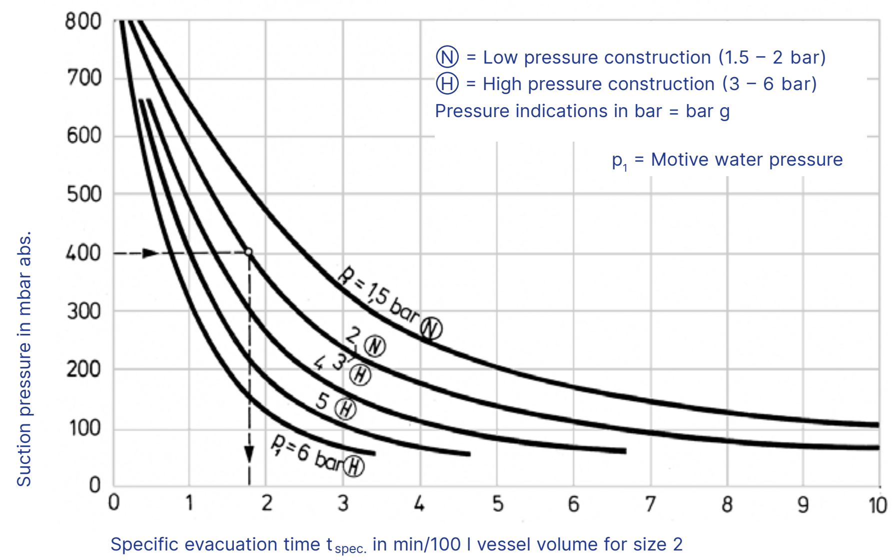
Parameters to be found: Pump size

Solution: From diagram fig. 3, for 400 mbar and 3 bar, a time of 1.8 min/100 l is found. For the evacuation of a vessel volume of 400 l, a liquid jet vacuum pump size 2 requires 4 x 1.8 = 7.2 minutes. However, as only 5 minutes are available the above formula is used to calculate the factor for the size of pump required:

$$F = \frac{1.8}{100 \cdot 5} \cdot 400 = 1.44$$

According to the table factor 1.5 corresponding to pump size 3 is closest to the calculated value. Pump size 3 is therefore selected. The motive liquid consumption is influenced by the suction pressure p_0. This is established by means of the curves in fig. 2.

Figure 3

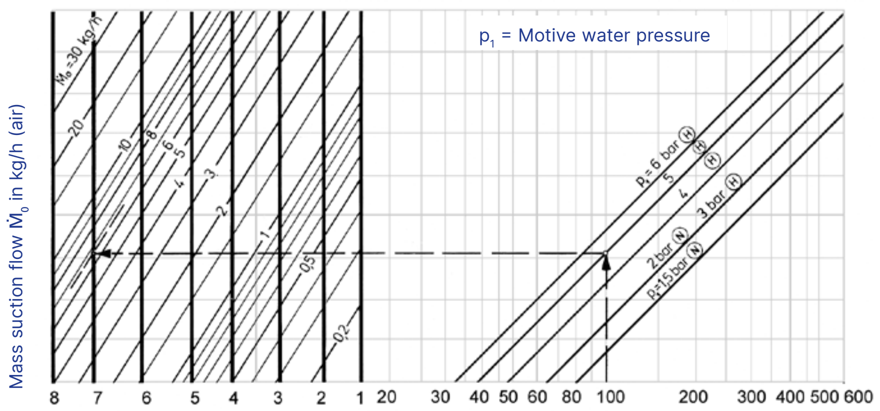


Liquid jet vacuum pump with flanged connections

Performance chart (Vacuum pump)

Diagram fig. 4 gives the mass suction flow in kg/h of air in relation to the suction pressure at various operating water pressures for 8 pump sizes. The curves are based on an operating water temperature of 20 °C. The motive liquid consumption or the motive liquid flow (circulating water operation) can be taken from diagram fig. 5.

Figure 4



Size | Suction pressure po in mbar abs. (for water at 20 °C)

Ⓝ = Low pressure construction (1.5 – 2 bar)
Ⓗ = High pressure construction (3 – 6 bar)
Pressure indications in bar = bar g

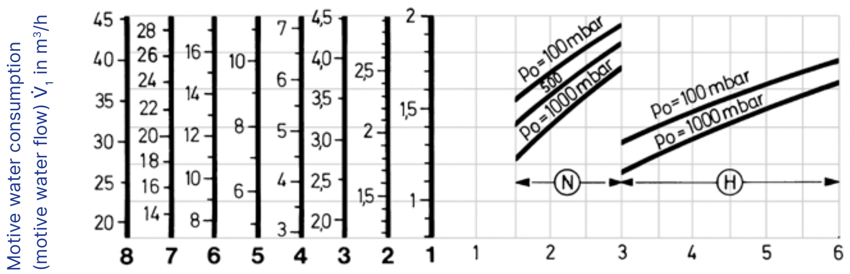
Design example

6 kg/h of air has to be continuously exhausted out of a plant. The suction pressure amounts to 100 mbar abs. A motive liquid pressure of 5 bar g is available. The motive water has a temperature of 20 °C.

Parameters to be found: Size of pump and motive water consumption.

Solution: From diagram fig. 4, for a suction pressure of 100 mbar and a motive water pressure of 5 bar g, pump size 7 with a mass suction flow of 6.8 kg/h is closest to the required suction volume. From diagram fig. 5, for a motive water pressure of 5 bar g and a suction pressure of 100 mbar a motive water consumption of 23.5 m³/h for the chosen size 7 can be found.

Figure 5



Size | Motive water pressure p₁ in bar

Ⓝ = Low pressure construction (1.5 – 2 bar)
Ⓗ = High pressure construction (3 – 6 bar)
Pressure indications in bar = bar g
p_0 = Suction pressure in mbar abs.

Performance chart (Pre-evacuator)

Evacuation time
Diagram fig. 6 gives the time in minutes a liquid jet vacuum pump size 4 needs to evacuate a vessel volume of 1 m³ to a defined suction pressure.
The selection of other sizes is achieved by the following conversion formula:

$$F = \frac{t_{spec.}}{t_{evac.}} \cdot V$$

F	Factor for the selection of the pump size
$t_{spec.}$	Specific evacuation time in min/m³ (from diagram fig. 6)
$t_{evac.}$	Expected evacuation time in minutes
V	Volume of vessel to be evacuated in m³

Size	1	2	3	4	5	6	7	8
Factor F	0.28	0.40	0.63	1	1.6	2.5	4	6.3

Design example

A vessel of 3 m³ is to be evacuated to 400 mbar in 10 minutes. The water pressure is 3 bar.

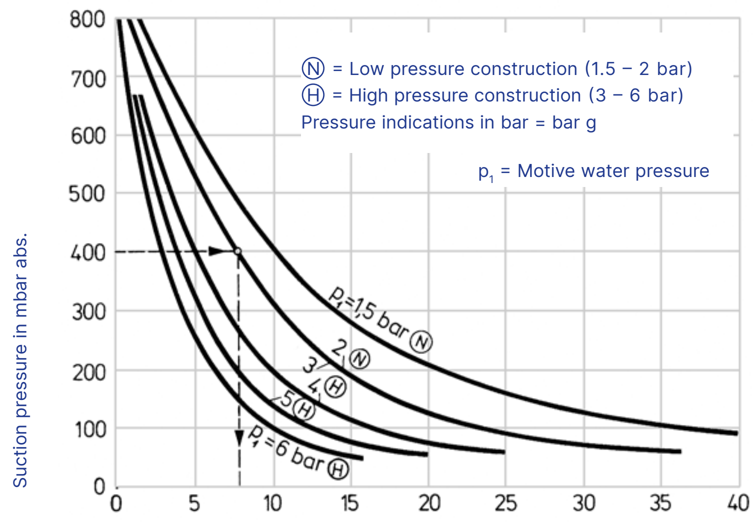
Parameters to be found: Size of the pump

Solution: From diagram fig. 6, for 400 mbar and 3 bar, a time of 8 min/m³ is found. For the evacuation of a vessel volume of 3 m³, a liquid jet vacuum pump size 4 requires 3 x 8 = 24 minutes. However, as only 10 minutes are available the above formula is used to calculate the factor for the size of pump required:

$$F = \frac{8}{10} \cdot 3 = 2.4$$

According to the table factor 2.5 corresponding to pump size 6 is closest to the calculated value. Pump size 6 is therefore selected. The motive liquid consumption is influenced by the suction pressure p_0. This is established by means of the curves in fig. 5.

Figure 6



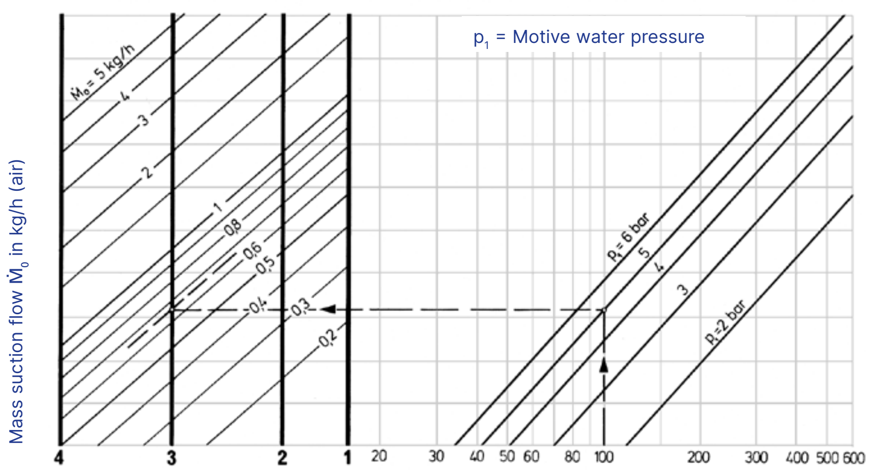
Specific evacuation time $t_{spec.}$ in min/m³ vessel volume for size 4

Liquid jet vacuum pump of PTFE

Performance chart (Vacuum pump)

Diagram fig. 7 gives the mass suction flow in kg/h of air in relation to the suction pressure at various operating water pressures for 4 pump sizes. The curves are based on an operating water temperature of 20 °C. The motive liquid consumption or the motive liquid flow (circulating water operation) can be taken from diagram fig. 8.

Figure 7



Size | Suction pressure p_0 in mbar abs. (for water at 20 °C)

Pressure indications in bar = bar g

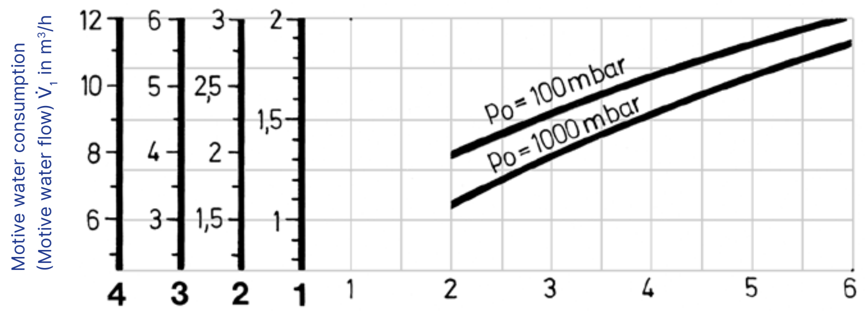
Design example

0,6 kg/h of air has to be continuously exhausted out of a plant. The suction pressure amounts to 100 mbar abs. A motive liquid pressure of 5 bar g is available. The motive water has a temperature of 20 °C.

Parameters to be found: Size of pump and motive water consumption

Solution: From diagram fig. 7, for a suction pressure of 100 mbar and a motive water pressure of 5 bar g, pump size 3 with a mass suction flow of 0.67 kg/h is closest to the required suction volume. From diagram fig. 8, for a motive water pressure of 5 bar g and a suction pressure of 100 mbar a motive water consumption of 5.5 m³/h for the chosen size 3 can be found.

Figure 8



Size | Motive water pressure p_1 in bar

Pressure indications in bar = bar g

p_0 = Suction pressure in mbar abs.

Performance chart (Pre-evacuator)

Evacuation time

Diagram fig. 9 gives the time in minutes a liquid jet vacuum pump size 3 needs to evacuate a vessel volume of 1 m³ to a defined suction pressure. The selection of other sizes is achieved by the following conversion formula:

$$F = \frac{t_{spec.}}{t_{evac.}} \cdot V$$

F	Factor for the selection of the pump size
$t_{spec.}$	Specific evacuation time in min/m³ (from diagram fig. 9)
$t_{evac.}$	Expected evacuation time in minutes
V	Volume of vessel to be evacuated in m³

Size	1	2	3	4
Factor F	0.33	0.5	1	2

Design example

A vessel of 2 m³ is to be evacuated to 400 mbar in 15 minutes. The water pressure is 3 bar.

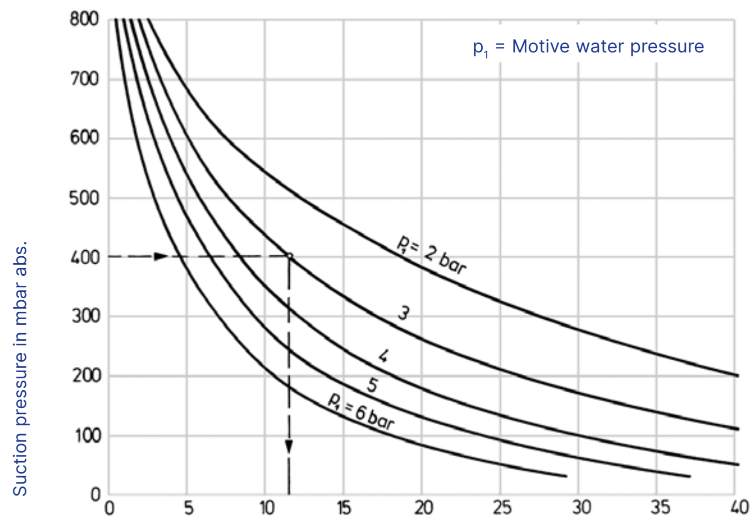
Parameters to be found: Size of the pump

Solution: From diagram fig. 9, for 400 mbar and 3 bar, a time of 12 min/m³ is found. For the evacuation of a vessel volume of 2 m³, a liquid jet vacuum pump size 3 requires 2 x 12 = 24 minutes. However, as only 15 minutes are available the above formula is used to calculate the factor for the larger size of pump required.

$$F = \frac{12}{15} \cdot 2 = 1.6$$

According to the table factor 2 corresponding to pump size 4 is closest to the calculated value. Pump size 4 is therefore selected. The motive liquid consumption is influenced by the suction pressure p_0. This is established by means of the curves in fig. 8.

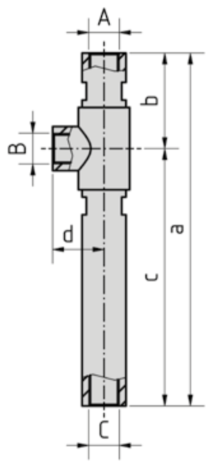
Figure 9



Specific evacuation time $t_{spec.}$ in min/m³ vessel volume for size 3

Pressure indications in bar = bar g

Liquid jet vacuum pumps with threaded connections



Connections, dimensions and weights

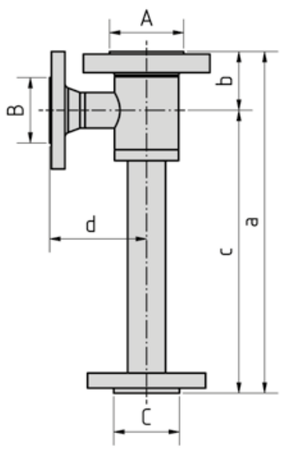
	Size	0	1	2	3
Operating water connection	A	G 1/2	G 3/4	G 1	G 11/2
Suction connection	B	G 1/2	G 1/2	G 3/4	G 1
Pressure connection	C	G 1/2	G 1/2	G 3/4	G 1
Dimensions in mm	a	240	260	310	405
	b	65	70	80	105
	c	175	190	230	300
	d	35	40	45	50
Weight in kg		0.9	1.4	2.3	3.1

Standard constructions:
I Housing: steel, motive nozzle: stainless steel
II Completely stainless steel

Special constructions: Hastelloy, Titanium, plastics (PVC, PP, PVDF, PTFE) etc.

Motive pressure has to be given with inquiry/order.
For inquiries please use our questionnaire.

Liquid jet vacuum pumps with flanged connections



Connections, dimensions and weights

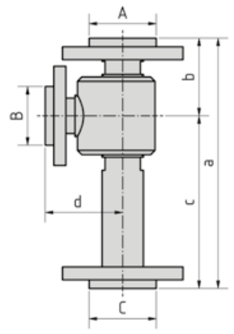
	Size	1	2	3	4	5	6	7	8
Operating water connection	A	25	25	32	40	50	65	65	80
Suction connection	B	20	20	25	32	40	40	50	65
Pressure connection	C	15	20	25	32	40	50	65	80
Dimensions in mm	a	207	267	347	407	478	608	778	963
	b	60	60	65	70	80	80	80	115
	c	147	207	282	337	398	528	698	848
	d	85	85	100	115	125	125	135	135
Weight in kg		8	10	13	18	26	35	55	65

Standard constructions:
I Housing: steel, motive nozzle: stainless steel
II Completely stainless steel
Flanges according to EN1092-1

Special constructions: Hastelloy, Titanium, plastics (PVC, PP, PVDF, PTFE) etc.

Motive pressure has to be given with inquiry/order.
For inquiries please use our questionnaire.

Liquid jet vacuum pumps of PTFE



Connections, dimensions and weights

	Size	1	2	3	4
Operating water connection	A	32	32	40	50
Suction connection	B	25	25	25	32
Pressure connection	C	32	32	50	65
Dimensions in mm	a	290	290	390	500
	b	90	90	95	105
	c	200	200	295	395
	d	90	90	100	110
Weight in kg		3	3	5	7

Standard constructions:
PTFE, loose flange made in GF-UP
Connections according to EN1092-1

Metal and special constructions:
For inquiries please use our questionnaire.

Please see “Liquid jet vacuum pumps with threaded connections”, ↗|fvp1,
and “Liquid jet vacuum pumps with flanged connections”, ↗|fvp2.

LIQUID JET GAS COMPRESSORS

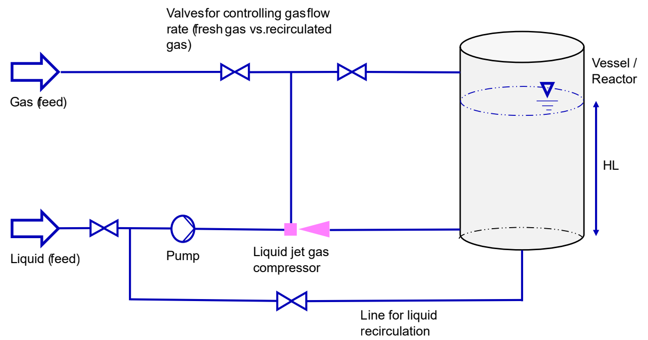
Applications

Liquid jet gas compressors are jet pumps for the conveyance and compression of gases at simultaneous mixing with the motive liquid.

Their operation is based on the liquid jet emerging from the motive nozzle hitting and entraining the surrounding gases and compressing them to a higher pressure.

Reference processes:

- Water treatment
- Gas phase analysis in electrolysis process and fuel cells
- Hydrogenation
- Biogas CO_2 mixtures
- Loop-reactors
- PVC production (Chlorine / Ethylene Dichloride)



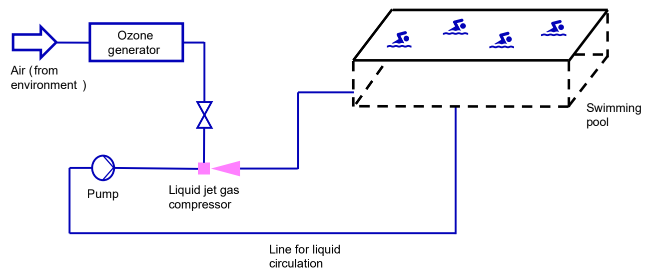
Schematic flow sheet for gassing a liquid using a liquid jet gas compressor (Advantage: Recirculation of residual gas possible with the same apparatus.)

Working principle

Liquid jet gas compressors are ejectors for the compression of gases and simultaneous mixing with the motive liquid. Their operation is based on the liquid jet emerging from the motive nozzle creating an under pressure which entrains the surrounding gases and compresses them to a higher pressure.

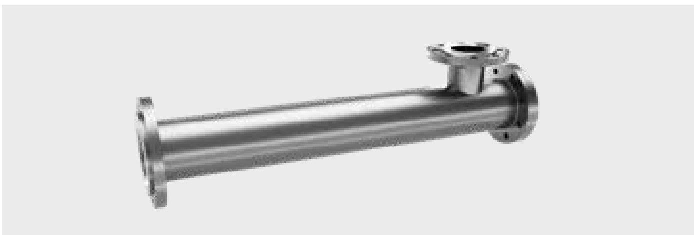
It is necessary for the many possible operating conditions that each liquid jet gas compressor is specially designed to achieve an optimum working efficiency.

Gases or steams which undergo a reaction with the motive liquid or which condense are calculated with a reduced suction flow rate. The required motive liquid flow is only determined for the reduced suction flow as the volume shrinking of the gas stream due to the reaction and/or condensation creates an under pressure as well.



Schematic flow sheet for desinfection of water in a swimming pool using ozone and a liquid jet gas compressor

In PTFE



In stainless steel

Performance chart

Fig. 10 shows the relation between the permissible suction ration

$$\varphi_{adm.} = \frac{\dot{V}_0}{\dot{V}_1} = \frac{m^3\ \text{Gas}}{m^3\ \text{Motive liquid}}$$

of the pressure difference to be overcome
$\Delta p = p - p_0$

and the effective motive liquid pressure
$\Delta p_1 = p_1 - p_0$

The suction ratio □ of sucked-in gas flow to the required motive liquid flow

- increases with increasing motive liquid pressure p_1.
- lowers with increasing compression □p_1.
- is independent of type and density of the gas to be conveyed.

Design example

for the selection of a liquid jet gas compressor

Given:
$\dot{V}_0$ = 13 m³/h of gas
p_0 = –0.2 bar (= 0.8 bar abs.)
p_1 = 3 bar
p = 0.7 bar

Parameters to be found:
Motive liquid flow $\dot{V}_1$ and size of the compressor

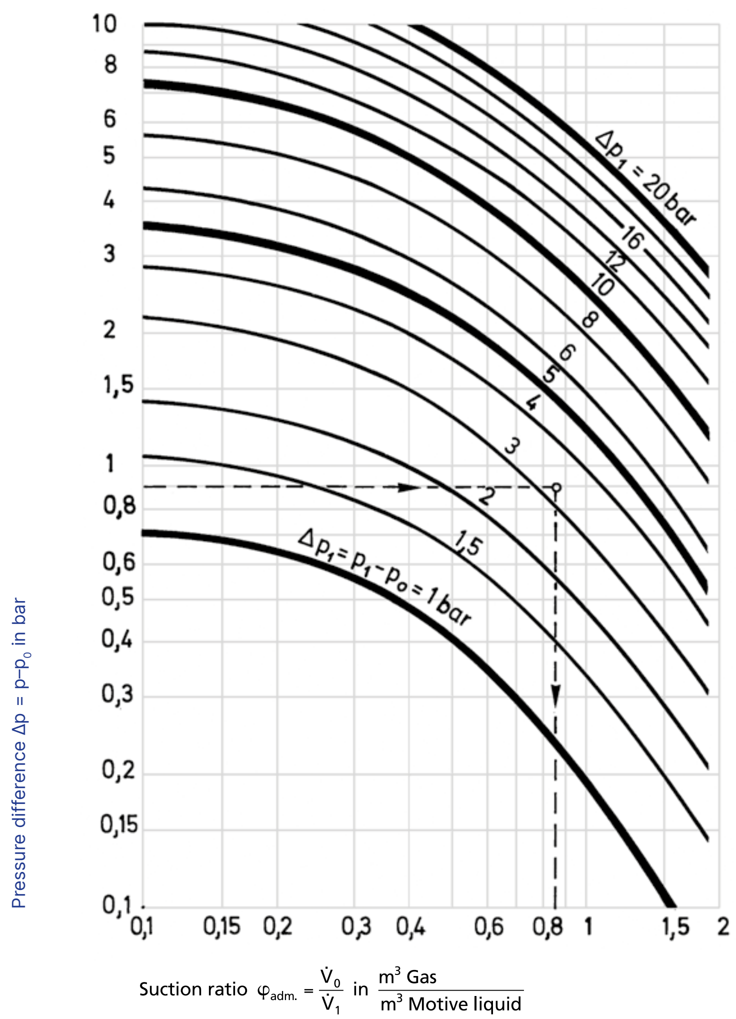
Solution:
$\Delta p = p - p_0 = 0.7 - (-0.2) = 0.9$ bar
$\Delta p_1 = p_1 - p_0 = 3 - (-0.2) = 3.2$ bar
From fig. 10 you will find for □p = 0.9 bar and Δp_1 = 3.2 bar:

$$\varphi_{adm.} = \frac{\dot{V}_0}{\dot{V}_1} = 0.85$$

This results in:

$$\dot{V}_1 = \frac{\dot{V}_0}{\varphi_{adm.}} = \frac{13}{0.85} = 15.3\ m^3/h$$

Figure 10



$\Delta p_1 = p_1 - p_0$ = Effective motive liquid pressure

Design conditions

It is necessary for the many possible operating conditions that each liquid jet gas compressor be specially designed to achieve optimum efficiency.

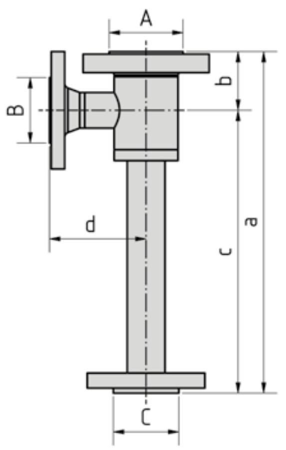
Gases or steams which undergo a reaction with the motive liquid or which condense are calculated with a reduced flow $\dot{V}_{OR}$. The required motive liquid flow is only determined for the reduced suction flow $\dot{V}_{OR}$.
The determination for the size of jet compressors is the motive liquid connection A (Illustration Metal Construction):

For a selected pipe pressure loss Δp of approx. 1 bar for a pipe length of 100 m, a connection diameter of DN 50 for a liquid velocity of w = 2.2 m/s results.

From the table for Metal Construction you will find
A = DN 50: size 4.

If a compressor in plastic design is selected, according to the table for Plastic Construction PVC, size 5, type G will be applicable.

Metal construction



Connections, dimensions and weights

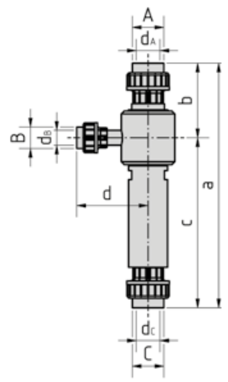
	Size	1	2	3	4	5	6	7	8
Liquid connection	A	25	32	40	50	65	65	80	100
Suction connection	B	20	25	32	40	40	50	65	80
Pressure connection	C	32	40	50	65	65	80	100	125
Dimensions in mm	a	270	350	410	480	480	530	730	950
	b	60	65	70	80	80	80	115	150
	c	210	285	340	400	400	450	615	800
	d	85	100	115	125	125	135	135	165
Weight in kg		10	13	15	22	22	30	45	98

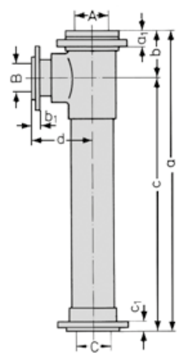
Standard constructions:
I Housing: steel, motive nozzle: stainless steel, inlet guide vane: PVC
II Housing: steel, inner surfaces lined with PFA, motive/mixing nozzle: PVC, inlet guide vane: PVC
III Completely stainless steel
Flanges according to EN1092-1

Special constructions: Hastelloy, Titanium, plastics (PP, PVDF, PTFE, PVC/GF-UP) etc.

For inquiries please use our questionnaire.

Plastic construction PVC


Type G


Type F

Connections, dimensions and weights

	Size	1	2	3	4	5	6	7	8	9	10
Liquid connection	A	20	25	32	40	50	65	80	100	125	150
Dimensions in mm	d_A	25	32	40	50	63					
	a_1						38	41	43	47	55
Suction connection	B	20	20	20	25	32	50	65	80	100	125
Dimensions in mm	d_B	25	25	25	32	40					
	b_1						27	30	33	36	41
Pressure connection	C	20	25	32	40	50	65	80	100	125	150
Suction connection	d_C	25	32	40	50	63					
	c_1						30	33	36	41	46
Dimensions in mm	a	280	320	410	530	610	600	675	825	1050	1250
	b	100	105	125	150	170	100	115	135	165	190
	c	180	215	285	380	440	500	560	690	885	1060
	d	115	115	120	140	160	125	146	175	215	248
Weight in kg		0.6	0.8	1.2	1.9	2.9	5.5	8.5	13	25	35
Type		G	G	G	G	G	F	F	F	F	F

Type G: with screw connections

Type F: Connections: loose flange made in GF-UP
Flanges according to EN1092-1

For inquiries please use our questionnaire.

LIQUID JET LIQUID PUMPS

Applications

Liquid jet liquid pumps are used for conveying and mixing liquids such as water, acids or lyes in water and waste water treatment plants.

An important range of application is for the dilution of acids or lyes to a definite final concentration such as is required in water treatment plants.

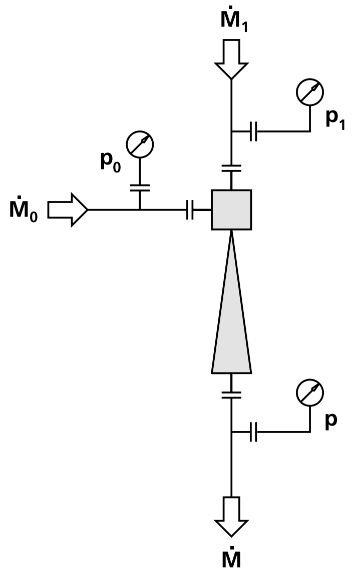
The ion exchangers at times have to be regenerated with acid (cation exchanger) or caustic (anion exchanger).

Working principle

Liquid jet liquid pumps are jet pumps that draw in a liquid mass flow by means of a motive liquid jet mass flow, mix the motive and suction flows, and deliver the mixed flow.

As with all jet pumps, the motive fluid has the highest pressure, the suction flow has the lowest pressure, and the pressure of the mixed flow is between the motive and suction pressures.

To deliver the mixture, the total delivery pressure must be overcome. This is determined by the geodetic height, the pipe resistance and the resistance of built-in parts, such as shut-off valves.



The liquid jet liquid pumps suck in the concentrated acid or lye and convey it into the exchangers at the respectively required mixing ratio.

Stainless steel, with flanged connections

PVC, construction KT, glued, form M

PVC, construction K, screwed, form M

PTFE, with flanged connections

Performance chart

The size of a liquid jet liquid pump is principally determined by the mixed flow $\dot{M}$ in kg/h. This can be found by the calculation as follows:

$$\dot{M} = \dot{M}_0 + \mu \cdot \dot{M}_0 = \dot{M}_0 (1 + \mu)$$

Ø	Mixed flow in kg/h
$Ø_1$	Suction flow in kg/h
m	Spec. liquid consumption in kg motive liquid / kg suction liquid

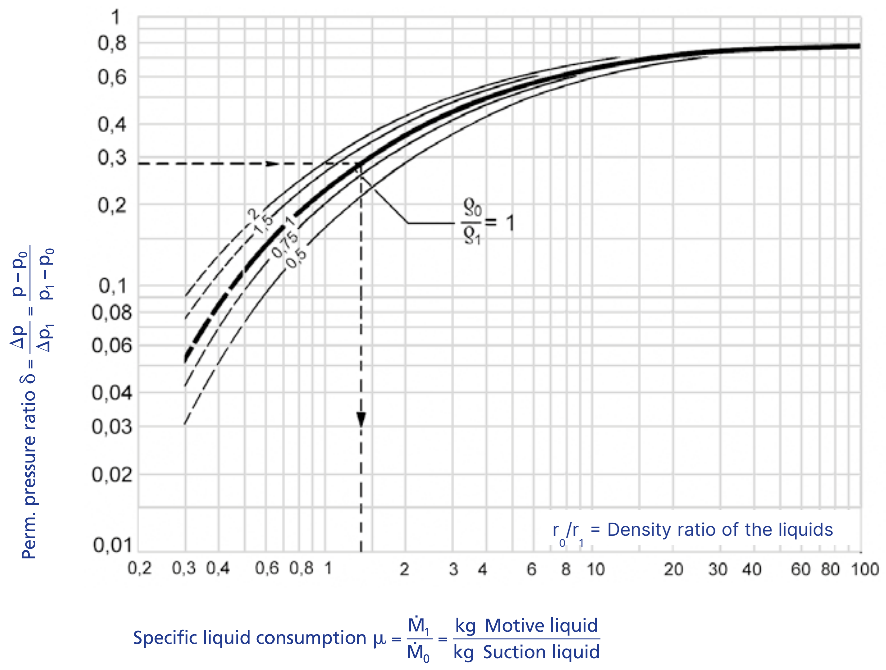
The motive liquid consumption is calculated as follows:

$$\dot{M}_1 = \mu \cdot \dot{M}_0 \text{ in kg/h}$$

Fig. 11 shows the relation between the pressure ratio δ, the specific liquid consumption μ and the density ratio $□_0/□_1$.

The specific liquid consumption □ in kg motive liquid/kg suction liquid is greater the higher the pressure ratio δ and is smaller the higher the effective motive liquid pressure, that means the higher the difference between motive pressure and suction pressure p_1 p_0 and the greater the density ratio $□_0/□_1$.

Figure 11



Design example

Given: Suction flow $\dot{M}_0$ = 1000 kg/h effluent
Suction liquid over pressure
p_0 = –0.2 bar = 2 m WC suction height
Motive liquid overpressure p_1 = 4 bar
Discharge pressure p = 1 bar g

Parameters to be found: Required motive liquid flow $\dot{M}_1$ and pump size

Solution:

$$\delta = \frac{\Delta p}{\Delta p_1} = \frac{p - p_0}{p_1 - p_0} = \frac{1 - (-0.2)}{4 - (-0.2)} = 0.286$$

The table on page 24 gives pump size 5 (max. mixed flow 3500 kg/h)

$$\text{With } \dot{M} = \dot{M}_1 + \dot{M}_0 = 1370 + 1000 = 2730 \frac{\text{kg}}{\text{h}}$$

Performance chart (PVC/PP)

Standard liquid jet liquid pumps of PVC/PP are available in 6 sizes but semi standard versions where the inside dimensions of such pumps will be specially designed and fabricated according to the given operation conditions are available too.

Design example

$\dot{M}_0$ = 100 kg/h hydrochloric acid with K_0 = 30 % is to be diluted with the motive liquid water with a concentration of K_1 = 0, to K = 4 %.

Motive liquid pressure p_1 = 2.5 bar g
Suction liquid pressure p_0 = 0 bar g
Discharge pressure p = 0.8 bar g

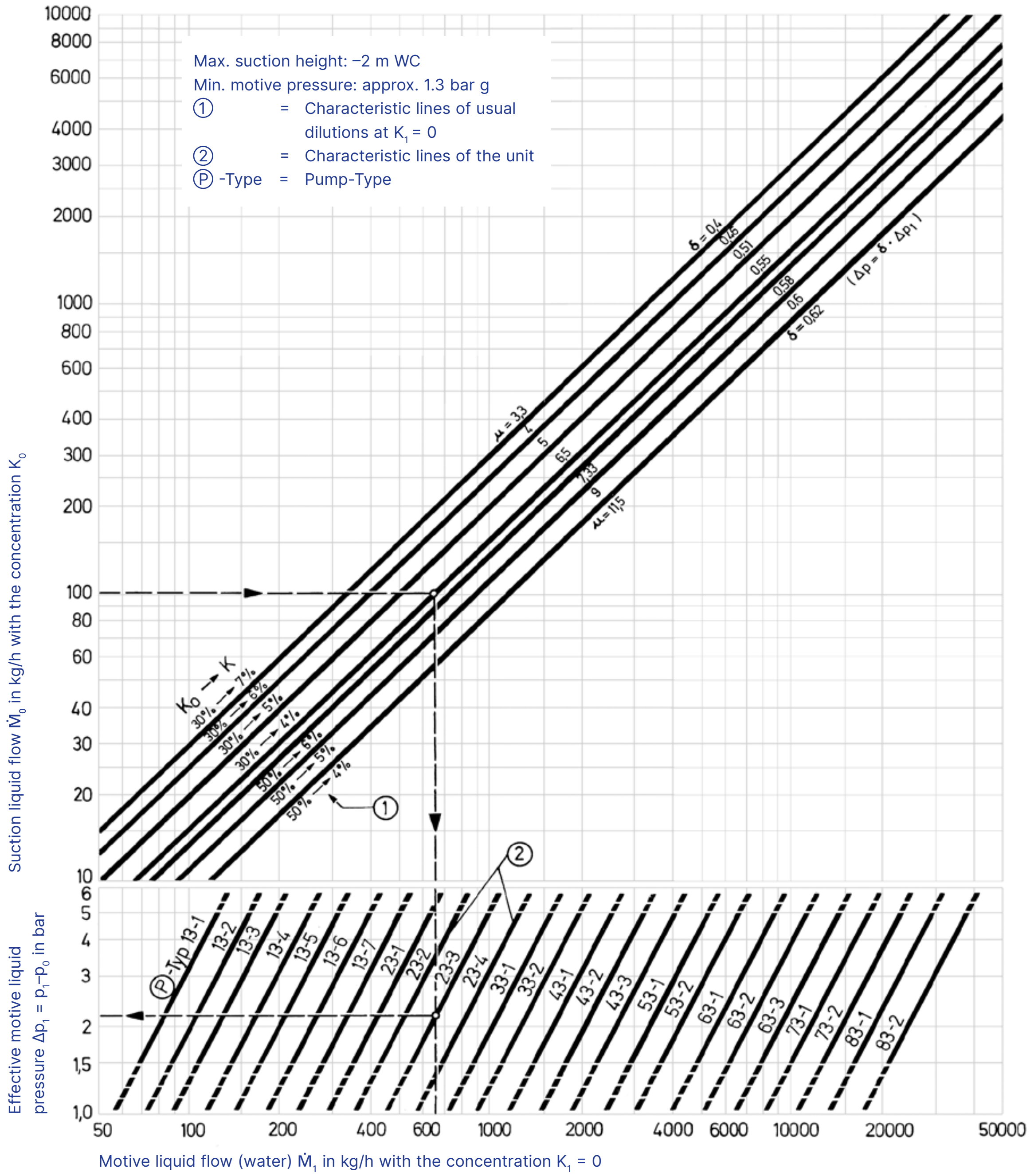
Solution: In the performance chart fig. 12 the horizontal from $\dot{M}_0$ = 100 kg/h intersects the dilution curve 30 % → 4 % giving on the abscissa $\dot{M}_1$ = 650 kg/h motive liquid flow. The intersection of the vertical $\dot{M}_1$ = 650 kg/h with the "Type" curve 23-3 gives on the ordinate in the lower part of the chart en effective motive pressure of $\Delta p_1 = p_1 - p_0$ = 2.2 bar.

By multiplying this value with the ▯ found on the dilution curve one can obtain the admissible total delivery pressure $\Delta p = p_1 \cdot \delta = 2.2 \cdot 0.55 = 1.21$ bar.

Thereby the achievable discharge pressure is p = 1.21 + p_0 = 1.21 bar and the actually required motive liquid pressure is $p_1 = \Delta p_1 + p_0$ = 2.2 bar.

A liquid jet liquid pump size KT2 or K2, type 23-3 is required.

Figure 12



Performance chart (PTFE)

The jet pumps are completely manufactured of PTFE. The pumps are, therefore, resistant to chemical attack. They are reliable and maintenance-free; the capital cost is low. Performance chart for a suction head of max. – 0.5 m liquid column

Design Example

Given: $\dot{M}_0$ = 200 kg/h sulphuric acid with K_0 = 96 % is to be diluted with motive liquid water, concentration K_1 = 0, to K = 6 %.

Motive liquid overpressure p_1 = 3.0 bar
Suction liquid overpressure p_0 = 0 bar
Discharge pressure p = 0.8 bar

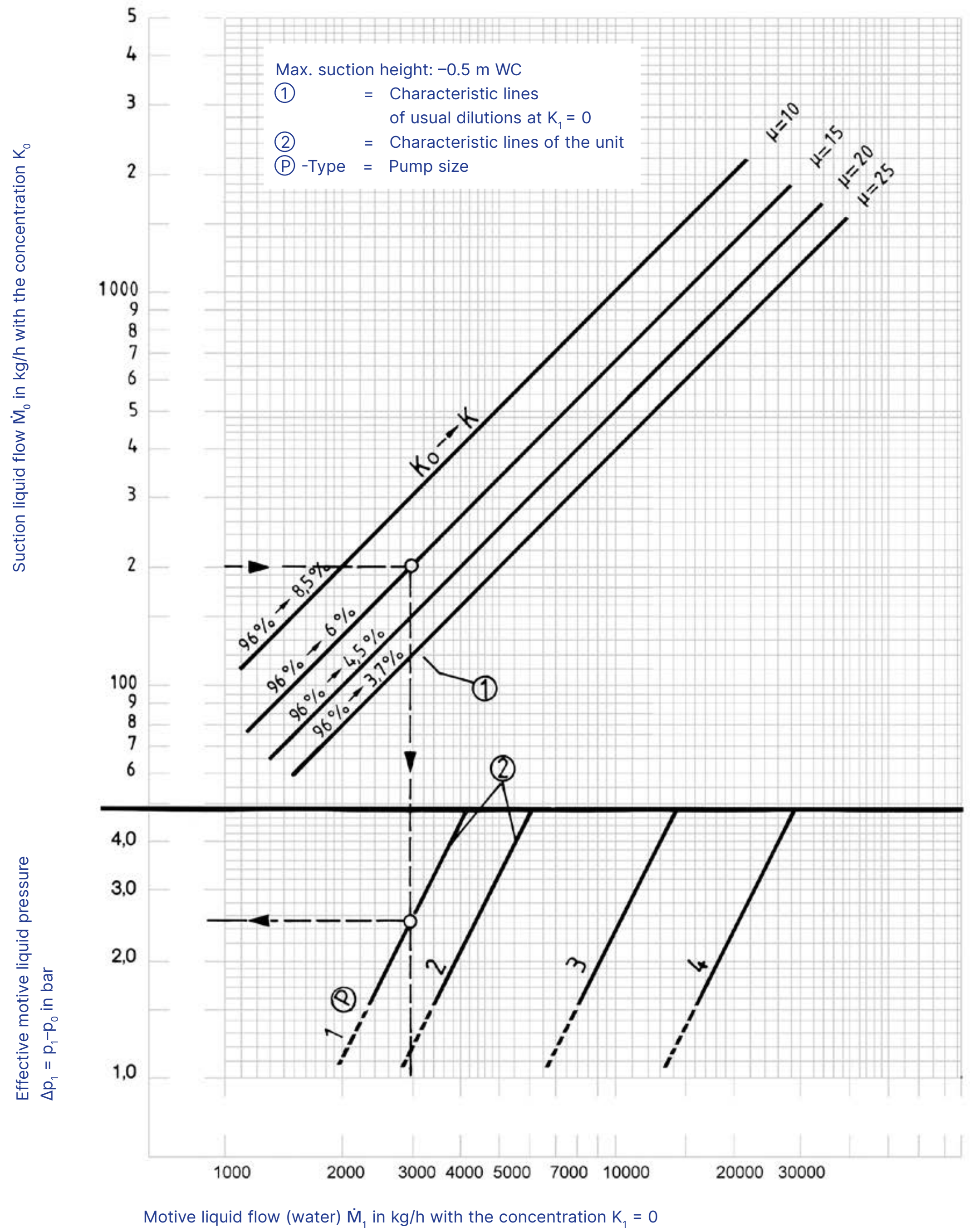
Solution: (see performance chart fig. 13) The horizontal from $\dot{M}_0$ = 200 kg/h intersects the 96 % → 6 % dilution curve giving on the abscissa $\dot{M}_1$ = 3000 kg/h motive liquid flow. The intersection of the vertical from $\dot{M}_1$ = 3000 kg/h with the size-line on the ordinate in the lower part of the diagram gives the effective, required motive liquid pressure of Δp_1 = 2.5 bar < 3.0 bar.

According to the performance chart, fig. 13,
the max. permissible discharge pressure amounts to 50 % of the motive pressure:

0.5 · 2.5 = 1.25 bar > 0.8 bar.

A liquid jet liquid pump size 1 is required.

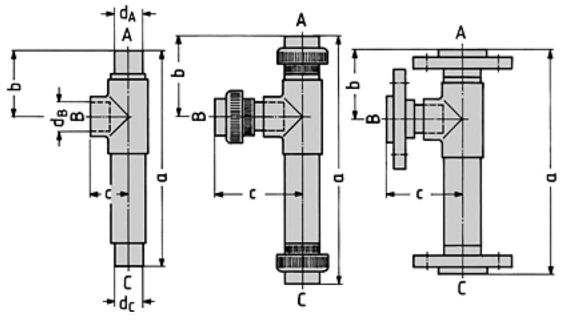
Figure 13



Standard liquid jet liquid pumps of PVC/PP

Construction KT

Form M Form G Form F



Max. mixed flow, connections, dimensions and weights
Plastic construction KT, glued (PVC), welded (PP)

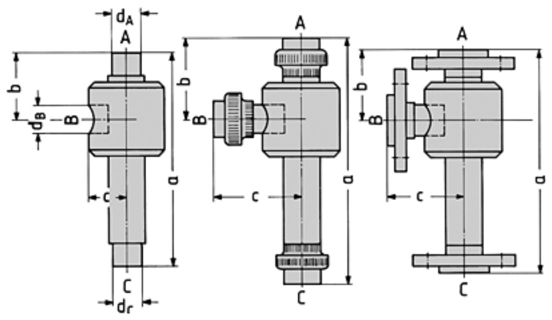
	Size	Form	KT 1	KT 2	KT 3	KT 4	KT 5	KT 6	KT 7	KT 8
Type			13-1 ... 13-7	23-1 ... 23-4	33-1 ... 33-2	43-1 ... 43-3	53-1 ... 53-2	63-1 ... 63-3	73-1 ... 73-2	83-1 ... 83-2
Nominal diameter	A		15	20	25	32	40	50	65	80
	B		15	20	25	32	40	50	65	80
	C		15	20	25	32	40	50	65	80
Dimensions in mm	d_A		20	25	32	40	50	63	75	90
	d_B		20	25	32	40	50	63	75	90
	d_C		20	25	32	40	50	63	75	90
Dimensions in mm	a	Form M	150	190	220	280	385	480	570	650
( ) Dimensions for	b	Form M	45	55	65	80	100	115	135	160
PP construction only	c	Form M	27	33	39	49	60	72	84	99
	(c)	Form M	(28)	(32)	(38)	(44)	(51)	(62)	(75.5)	(88)
Dimensions in mm	a	Form G	208	254	290	362	481	598	680	782
( ) Dimensions for	(a)	Form G	(212)	(256)	(290)	(358)	(473)	(584)	-	-
PP construction only	b	Form G	74	87	100	121	148	174	190	226
	(b)	Form G	(76)	(88)	(100)	(119)	(144)	(167)	-	-
	c	Form G	100	115	130	150	180	210	215	245
Dimensions in mm	a	Form F	156	196	226	286	391	486	576	660
( ) Dimensions for	(a)	Form F	(160)	(200)	(230)	(290)	(395)	(490)	(580)	(664)
PP construction only	b	Form F	48	58	68	83	103	118	138	165
	(b)	Form F	(50)	(60)	(70)	(85)	(105)	(120)	(140)	(167)
	c	Form F	90	100	100	115	125	145	165	185
Max. mixed flow in kg/h			500	1,200	2,000	3,500	6,000	12,000	25,000	50,000

Standard
Size, type, form and material must be given in all orders for standard liquid pumps, e.g. size KT1, type 13-3, form G, PP. Standard liquid jet liquid pumps of PVC/PP are available in the 6 above-mentioned constructions.

Semi standard
The inside dimensions of such pumps will be specially designed and fabricated according to the given operation conditions. These pumps are therefore tailor-made constructions with standard structural dimensions.

Construction K

Form M Form G Form F



Max. mixed flow, connections, dimensions and weights
Plastic construction K, screwed

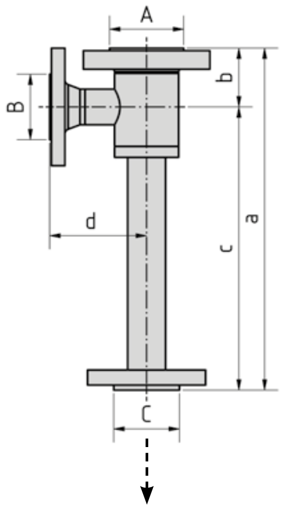
	Size	Form	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8
Type			13-1 ... 13-7	23-1 ... 23-4	33-1 ... 33-2	43-1 ... 43-3	53-1 ... 53-2	63-1 ... 63-3	73-1 ... 73-2	83-1 ... 83-2
Nominal diameter	A		15	20	25	32	40	50	65	80
	B		10	20	20	20	25	32	40	65
	C		15	20	25	32	40	50	65	100
Dimensions in mm	d_A		20	25	32	40	50	63	75	90
	d_B		16	25	25	25	32	40	50	75
	d_C		20	25	32	40	50	63	75	110
Dimensions in mm	a	Form M	155	190	200	260	385	460	520	800
	b	Form M	65	70	70	85	100	110	145	210
	c	Form M	30	40	40	45	60	60	80	97.5
Dimensions in mm	a	Form G	213	254	270	342	481	578	650	951
( ) Dimensions for	(a)	Form G	(217)	(256)	(270)	(338)	(473)	(564)	-	-
PP construction only	b	Form G	94	102	105	126	148	169	210	284
	(b)	Form G	(96)	(103)	(105)	(124)	(144)	(162)	-	-
	c	Form G	100	115	115	120	140	160	180	200
Dimensions in mm	a	Form F	161	196	206	266	391	466	526	810
( ) Dimensions for	(a)	Form F	(165)	(200)	(210)	(270)	(395)	(470)	(530)	(814)
PP construction only	b	Form F	68	73	73	88	103	113	148	215
	(b)	Form F	(70)	(75)	(75)	(90)	(105)	(115)	(150)	(217)
	c	Form F	90	100	100	100	120	140	160	180
Max. mixed flow in kg/h			500	1,200	2,000	3,500	6,000	12,000	25,000	50,000

Special constructions
Liquid pumps for dilutions, applications and materials other than shown in diagram fig. 12 are special constructions. Design, dimensions and connection dimensions on demand.

All connections for form M and G are provided as glued or welded connections.

For inquiries please use our questionnaire.

Liquid jet liquid pumps of steel or stainless steel



max. mixed flow

Connections, dimensions and weights

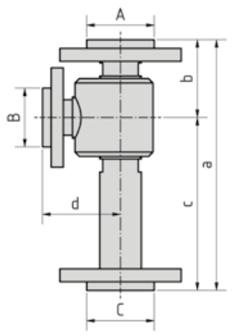
	Size	3	5	7	9	11	12	13	14	15
Max. mixed flow in kg/h		1,200	3,500	6,000	12,000	24,000	32,000	40,000	70,000	100,000
Nominal	A	20	25	32	40	50	65	65	80	100
diameter	B	20	20	25	32	40	40	50	65	80
	C	20	32	40	50	65	65	80	100	125
Dimensions	a	153	270	350	410	480	480	530	730	950
in mm	b	42	60	65	70	80	80	80	115	150
	c	111	210	285	340	400	400	450	615	800
	d	80	85	100	115	125	125	135	135	165
Weight in kg		5	10	13	15	22	22	30	45	98

Standard constructions:
I Housing: steel, motive nozzle: stainless steel
II Housing: steel, inner surfaces lined with PFA, motive/mixing nozzle: PVC
III Completely stainless steel
Flanges according to EN1092-1

Special constructions: of PTFE, PVDF, Titanium, Hastelloy etc. on demand.

For inquiries please use our questionnaire.

Standard liquid jet liquid pumps of PTFE



Connections, dimensions and weights

	Size	1	2	3	4
Service water connection	A	32	32	40	50
Suction connection	B	25	25	25	32
Pressure connection	C	32	32	50	65
Dimensions in mm	a	290	290	390	500
	b	90	90	95	105
	c	200	200	295	395
	d	90	90	100	110
Weight in kg		3	3	5	7

Standard constructions:
PTFE, loose flange made in GF-UP
Connections according to EN1092-1

For inquiries please use our questionnaire.

LIQUID JET SOLIDS PUMPS

Applications

Liquid jet solids pumps are used to convey sand, gravel, salt, activated carbon, ion exchange resin, and other types of solids; to fill and empty reactors with reactor mass or marble gravel in decarbonizing and deacidifying plants of water and effluent treatment plants; to add precipitating agents in dirty water and effluent water treatment.

Working principle

Liquid jet solids pumps are jet pumps which, with the support of a motive liquid, can convey flowable granulate material.

The material to be conveyed flows through a hopper into the jet pump. The motive liquid, in most cases water, emerges from the motive nozzle at a high velocity into the mixing chamber of the pump, entraining the material present in the mixing chamber.

Depending upon the type of material to be conveyed, rinse water must be sprayed into the hopper in order to maintain a constant flow.

The mixture of liquid and entrained material can be conveyed directly to the point of application, by pipe or hose.

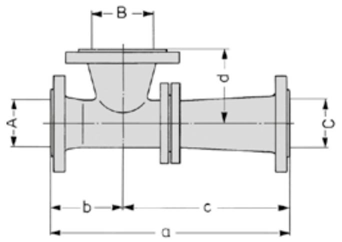
Liquid jet solids pumps can also be supplied as complete units with hopper and rinse water connection. Stationary units as well as mobile units are available.

Standard liquid jet solids pump

Stantionary liquid jet solids pump

Mobile liquid jet solids pump

Standard liquid jet solids pumps



Flow rate, connections, dimensions and weights

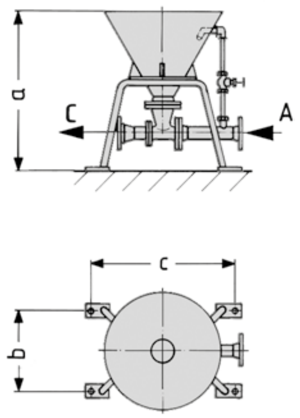
	Size	1	2	3	4
Flow rate marble/gravel in kg/h		500	1000	2500	5000
Motive water flow at 3 bar g in m³/h		2.4	4.8	12.0	24.0
Nominal diameter	A	25	32	50	80
	B	40	65	80	100
	C	25	32	50	80
Dimensions in mm	a	210	265	355	580
	b	50	65	80	90
	c	160	200	275	490
	d	90	100	125	140
Weight in kg		8	11	15	30

Standard constructions:
I Housing: cast iron EN-GJL-200 (GG20), motive and mixing nozzles: stainless steel (replaceable)
II Housing: completely stainless steel
Flanges according to DIN PN 10

Special constructions: on request
Please give size, type and material with inquiry or order.
For inquiries please use our questionnaire.

Stationary liquid jet solids pumps

inclusive standard liquid jet solids pump



Flow rate, connections, dimensions and weights

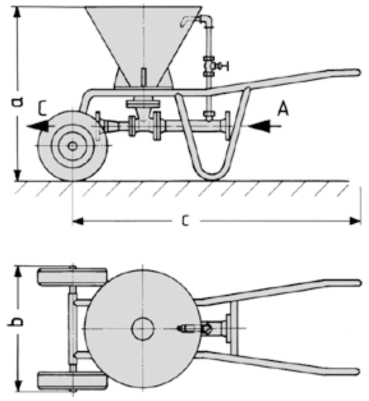
	Size	1	2	3	4
Flow rate marble/gravel in kg/h		500	1000	2500	5000
Rinse water in kg/h		100	200	500	1000
Motive water flow at 3 bar g in m³/h		2.4	4.8	12.0	24.0
Nominal diameter	A	25	32	50	80
	C	25	32	50	80
Storz coupling		D	C	C	B
Dimensions in mm	a	1045	1045	1035	1035
	b	600	600	600	600
	c	800	800	800	800
Weight in kg		50	55	60	80
Hopper volume in l		62	62	64	72

Standard constructions:
Hopper and frame: steel
Connecting pipes: steel/VA
Flanges according to EN1092-1/storz coupling

Special constructions: on request
For inquiries please use our questionnaire.

Mobile liquid jet solids pumps

inclusive standard liquid jet solids pump



Flow rate, connections, dimensions and weights

	Size	1	2	3	4
Flow rate marble/gravel in kg/h		500	1000	2500	5000
Rinse water in kg/h		100	200	500	1000
Motive water flow at 3 bar g in m³/h		2.4	4.8	12.0	24.0
Nominal diameter	A	25	32	50	80
	C	25	32	50	80
Storz coupling		D	C	C	B
Dimensions in mm	a	990	990	990	990
	b	720	720	720	720
	c	1550	1550	1550	1550
Weight in kg		60	65	70	90
Hopper volume in l		62	62	64	72

Standard constructions:
Hopper and frame: steel
Connecting pipes: steel/VA
Flanges according to EN1092-1/storz coupling

Special constructions: on request
For inquiries please use our questionnaire.

Sugar conveying (examples from beverage industry)

Examples of capacity data					
Motive flow rate	kg/h	25.000	50.000	75.000	100.000
Motive pressure	bar,abs	up to 10			
Sugar flow rate	kg/h	5.000	10.000	15.000	20.000
Discharge pressure	bar,abs	up to 4			

LIQUID JET MIXERS

Applications

Liquid jet mixers are jet pumps to mix and circulate liquids. The range of applications for liquid jet mixers is only limited by the viscosity of the liquid to be mixed. As a rule, jet mixers can be used in all cases where the liquid to be mixed can still be supplied by a centrifugal pump.

Liquid jet mixers are mainly used in vessels, storage tanks and neutralization basins.

Working principle

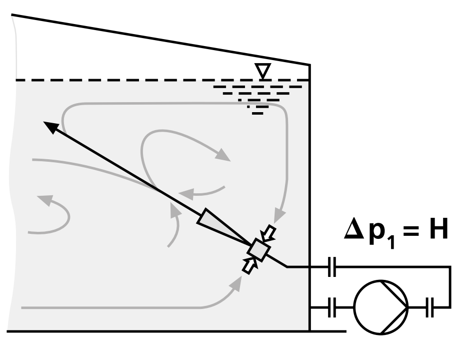
Liquid jet mixers are jet pumps to mix and circulate liquids inside of a tank. The range of applications is limited by the viscosity (max. 500 mPas) for Newtonian fluids.

The liquid jet coming out of the motive nozzle generates a partial vacuum in the inlet cone of the diffuser. Therefore, a liquid flow is extracted from the tank and entrained. The motive jet mixes with the entrained liquid and accelerates its flow.

There are two recirculation loops:
- Inner recirculation loop (liquid jet mixer)
- Outer recirculation loop (circulation pump)

Due to the entrained suction flow, the total mixing flow increases up to four times the motive flow. This results in shorter and more efficient mixing.

Figure 14



Cast iron, with threaded connenctions

Plastic, with flanged connections

Stainless steel, with welding end

Mixing time

Definition mixing time:
In this context, the mixing time is defined as the time, it takes for one fluid element to travel through the whole tank content and end up at the same starting point.

It depends highly on the mixing technology and energy input. Compared to agitators and because of the relative high energy efficiencies of pumps, the liquid jet mixing technology usually needs less energy for the same mixing quality after a certain time.

Further influencing parameters are:
- viscosity
- density
- particle laoding

Design of the circulation pump

The selection of the required circulation pump is determined by the effective motive liquid pressure Δp_1 and by the motive liquid flow $\dot{V}_1$.
In determining the required motive liquid pressure Δp_1 you must consider the two possible flow arrangements for the circulation pump:

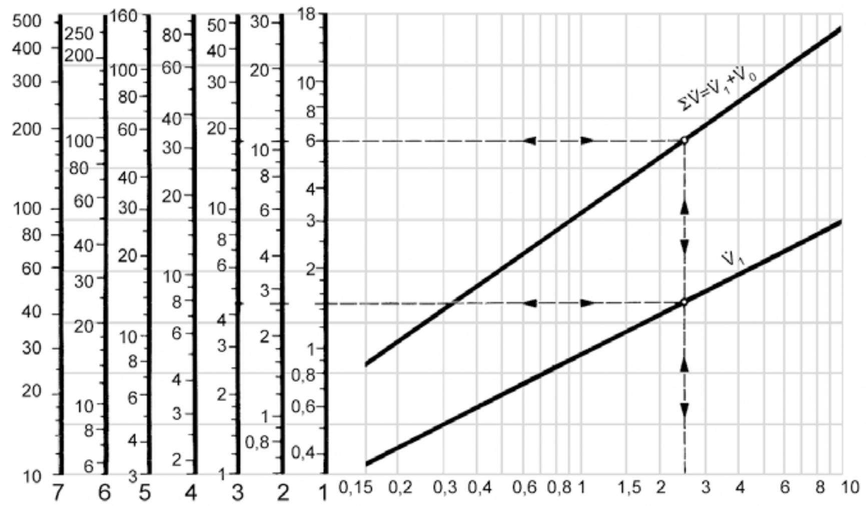
1. The circulation pump sucks in the circulation liquid from the tank (fig. 14). The static liquid pressure H_{stat} in this case has no influence on the delivery head H as the inlet height at the suction connection is so arranged that Δp_1 = H.

2. The circulation pump sucks in external liquid and must deliver it against the static liquid pressure in the tank (fig. 4). In this case, the following shall apply:

$\Delta p_1 = H - H_{stat}$

H Delivery head of the pump

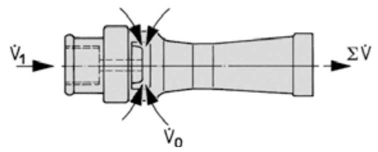
Figure 15



Size
Series 80

Δp_1 = Effective liquid pressure on the nozzle in bar
Optimum pressure range Δp_1 : 1 to 4 bar

Performance chart for standard sizes 1–7
Table only valid for water liquid properties 1000 kg/m³ 1mPas



Design example

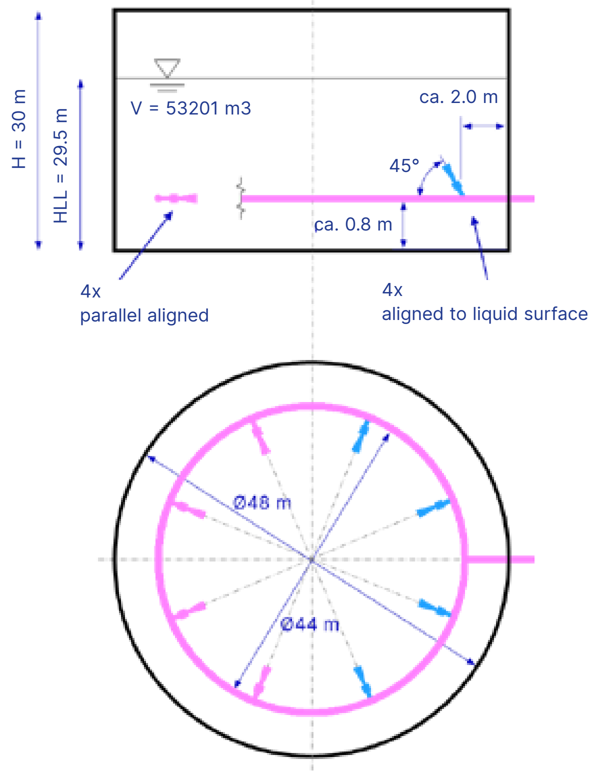
Customer focused design
Our jet mixers are adapted to the conditions on site.

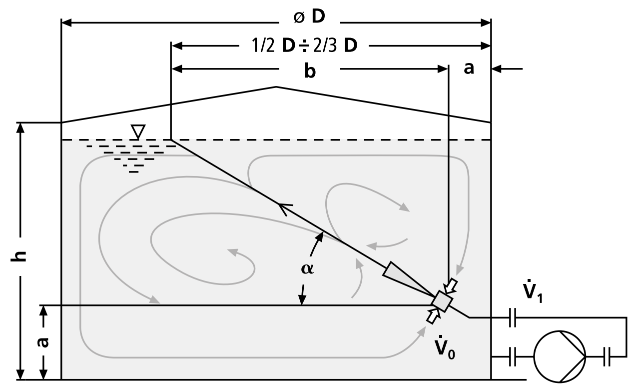
The parameters that determine the final design are
- the tank size.
- the medium to be mixed (density and viscosity).
- the capacity of the circulation pump.
- special specifications of the customer (e.g. the mixing time).

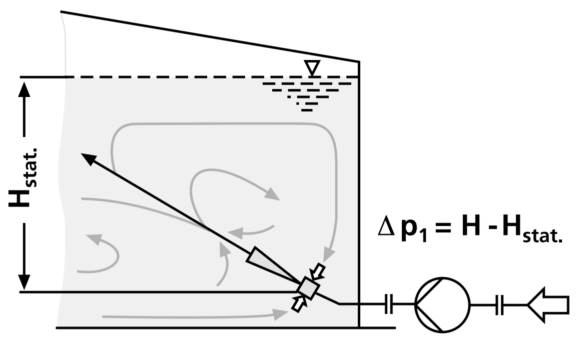
GEA's experts prepare a proposal for the mixer arrangement for each application. In this way, a good and common solution can be found at a high technical level.

We do not only sell our components; it is especially important to us that they also work perfectly. Customer satisfaction is our top priority.

Jet mixers are equally distributed on circumference

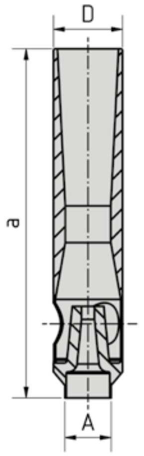






Connections, dimensions and weights

Liquid jet mixer with welding end type 37.1



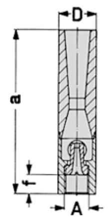
Cast iron	**Size**	1-80	2-80	3-80	4-80	5-80	6-80	7-80
Motive fluid connection	A	20	25	40	40	50	80	100
Motive fluid connection	a	170	220	265	345	400	495	610
	D	40	50	50	60	79	112	140
Weight in kg		1	1.7	2	2.7	6	15	27

Standard constructions: Completely in stainless steel 1.4301

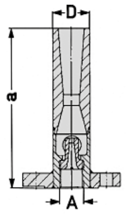
Special constructions: Other materials may be are available on request.

For inquiries please use our questionnaire.

Stainless steel



	Size	1-80	2-80	3-80	4-80	5-80	6-80	7-80
Motive liquid connection	A	G 3/4	G 1	G1 1/2	G1 1/2	G 2	G 3	G 4
Dimensions in mm	a	170	220	265	345	400	495	610
	D	45	55	55	63	79	112	140
	f	20	25	24	25	30	41	50
Weight in kg		1.4	2.8	2.8	4	7	18	31



	Size	1-80	2-80	3-80	4-80	5-80	6-80	7-80
Motive liquid connection	A	20	25	40	40	50	80	100
Dimensions in mm	a	170	220	265	345	400	495	610
	D	45	55	55	63	79	112	140
Weight in kg		2.2	3.5	4.5	5.5	9	22	35

Standard constructions: I Completely stainless steel 1.4571,
II Completely stainless steel 1.4301, threaded connections according to ISO 228, flanges according to EN1092-1

GEA JetmixStar

Mixing optimization thanks to CFD simulation
The GEA JetmixStar consists of a customized, jet mixer system validated by using a CFD (Computational Fluid Dynamics) model.

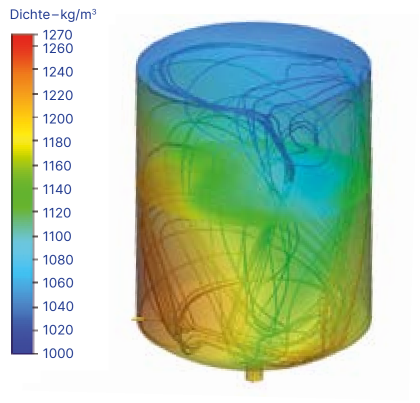
Liquid jet mixers are based on proven jet pump technology and often used to mix and circulate liquids in vessels, reactors, storage tanks and neutralization basins. If one or several of such liquid jet mixers are correctly arranged, a three-dimensional flow is created in the tank which mixes all liquid and solid contents in the tank homogeneously.

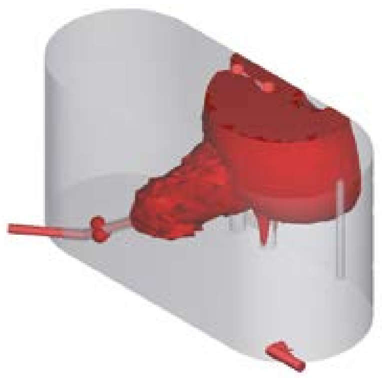
GEA's experts prepare a proposal for the mixer arrangement for each application. In this way, a good and common solution can be found at a high technical level and under consideration of energy efficiency. CFD simulations lead to additional cost but enable us to fine tune the mixing process. This optimization provides a more detailed view into local mixing effects and may lead to a reduction of operating costs.

What are the advantages of GEA JetmixStar?
- It is based on estimation calculations and proven by CF supported analysis, to achieve the optimum for the mixing process.
- Energy and cost saving: Mixing time can be reduced significantly, dead zones can be detected, forces on e.g. floating roofs can be evaluated.
- Local flow conditions can be checked and impacts on tank internals (e.g. floating roofs) can be examined.

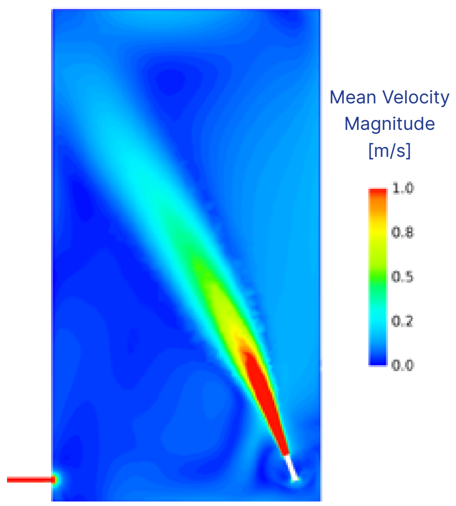
The parameters that determine the final design are:
- the tank size
- the medium to be mixed (density and viscosity)
- the capacity of the circulation pump
- special specifications of the customer (e.g. the mixing time)
- etc.

Figure 16





A numerical flow simulation (CFD) as in fig. 16 is available on request.



LIQUID JET VENTILATORS

Applications

Liquid jet ventilators are used to draw off air, gases or vapor. They are designed to suck in gas flows at small pressure differences. The pressure gain (compression) which these units can archive is in the range between 1 and 20 mbar.

Working principle

Liquid jet ventilators operate on the jet pumps principle. Their action is based on the jet of motive liquid which emerges from the motive nozzle entraining and conveying the surrounding gas.

Operating characteristics
The specific motive liquid requirement in m³ of liquid per m³ of air or gas
- decreases with higher motive liquid pressure p_1
- increases with rising, required compression Δp
- is independent of nature and density off the drawn off gases

In PVC

Design example

A liquid jet ventilator has to convey approximately 400 m³/h air. The available motive water pressure is 3 bar g.

Parameters to be found:
Maximum compression Δp in mbar
Size of ventilator
Motive liquid consumption in m³/h

Solution: Fig. 18 shows that a ventilator size 4 produces a compression of Δp = 5 mbar. The operating point lies within the area of best efficiency. Therefore the ventilator is suitable for the required duty.

Figure 17

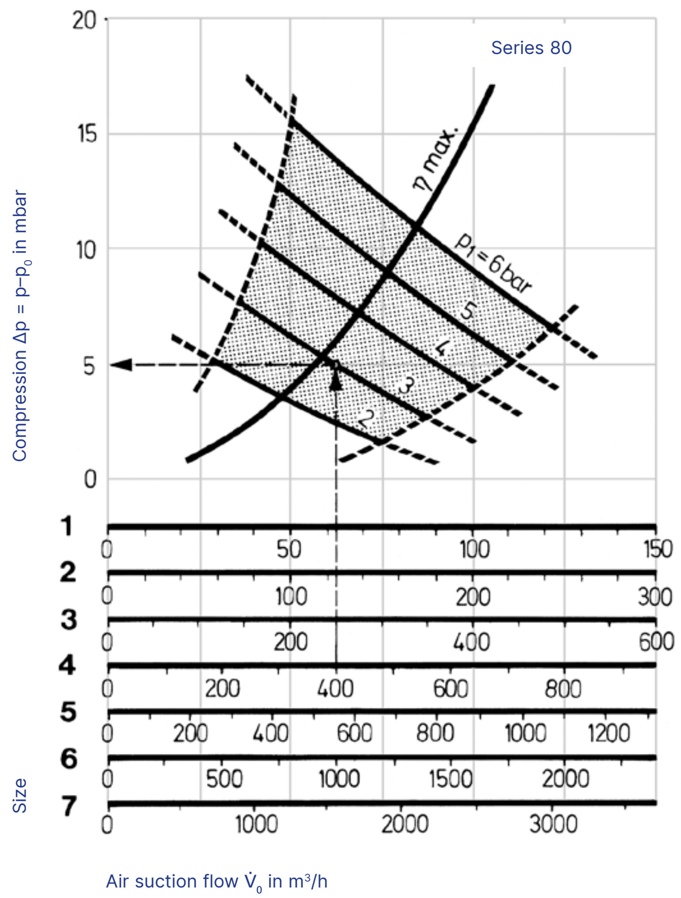
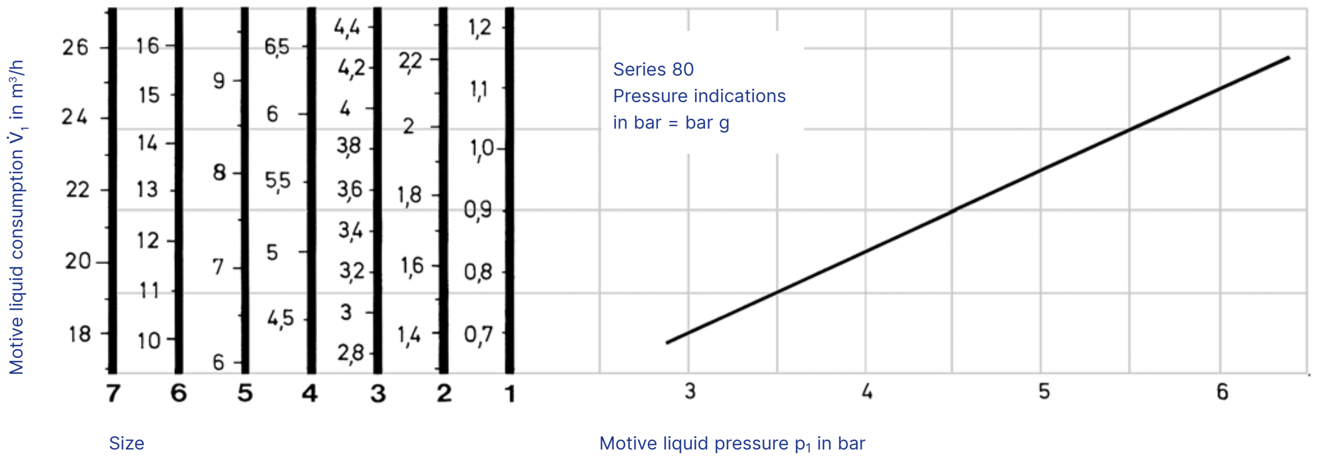
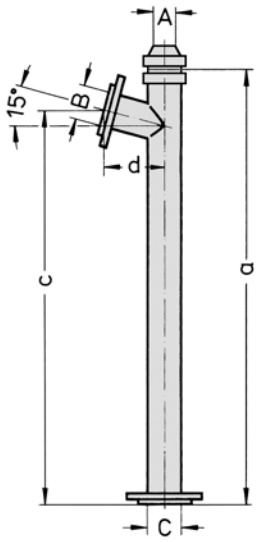


Figure 18





Connections, dimensions and weights

Series 80	Size	1	2	3	4	5	6	7
Motive liquid connection	A	15	25	25	32	32	50	65
Suction connection	B	50	65	100	125	150	200	250
Pressure connection	C	50	65	100	125	150	200	250
Dimensions in mm	a	1025	1300	1750	2000	2350	2750	3000
	c	925	1175	1625	1875	2125	2600	2850
	d	150	175	200	225	250	300	325
Weight in kg								
Steel		9	14	34	50	77	148	220
Stainless steel		9	14	28	37	51	75	105
Plastic material (PP)		4	5	8	11	15	18	25

Standard constructions:
I Housing: steel, motive nozzle: bronze, twist piece: PVC
II Completely stainless steel 1.4571
III Completely stainless steel 1.4541
IV Completely PVC, loose flanges: GRP
V Completely PP, loose flanges: GRP
Flanges according to EN1092-1

Special constructions: Titanium, Hastelloy, glass-fibre reinforced plastic (GFK) etc.

For special constructions dimensional modifications are subject to change.
When ordering standard units size, type and materials of construction should be given.

For inquiries please use our questionnaire.

STEAM JET EJECTORS

Applications

Steam jet pumps are particularly appropriate as vacuum pumps, as they can easily handle large vacuum volumes. Single stage jet pumps, which convey against atmospheric pressure are used for the production of vacuum down to a suction pressure of approx. 100 mbar.

For lower suction pressures multi-stage steam jet vacuum pumps are used, with or without intermediate condensation
Steam jet vacuum pumps have a tailor-made design depending on the individual requirements. In this way optimum efficiency is achieved.

Working principle

If a plant is to be evacuated within a given time, for example, during start-up, and the vacuum pump which maintains the operational vacuum takes longer than the given time, a jet pump is added to speed up the evacuation. This jet pump is called pre-evacuator or start-up jet pump.

In order to determine whether a pre-evacuator is required, the evacuation time of the vacuum pump has to be calculated.

Single-stage start-up jet pumps can, according to the motive steam pressure, achieve a final pressure of approx. 80 mbar. For lower pressures a two-stage start-up jet pump must be used.

In metal

In graphite

In stainless steel

Steam jet Ejector operated as Vacuum Pump

Design example

It is required to extract $\dot{M}_0$ = 50 kg/h of air at 20 °C from a suction pressure of

p_0 = 200 mbar. A motive steam pressure of
p_1 = 10 bar g is available.

From the diagrams fig. 1 and fig. 2, the required motive steam flow as well as the suction connection diameter can be ascertained in relation to the suction pressure and suction flow.

The overall dimensions of the equipment are fixed in relation to the suction connec- tion diameter.

Fig. 1 shows a specific steam consumption of

$$\mu = 3\ \frac{kg\ \ Steam}{kg\ \ Air}$$

The steam consumption is, therefore,

$$\dot{M}_1 = \mu \cdot \dot{M}_0 = 3 \cdot 50 = 150\ \frac{kg}{h}$$

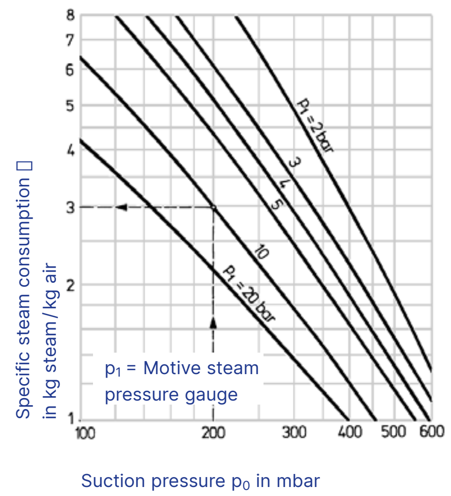
In fig. 2 the operating point suction flow = 50 g/h and suction pressure = 200 mbar is between the curves for DN 40 and DN 50.

DN 50 is chosen as the curves in fig. 2 give the maximum possible suction flow for each particular size. The dimensions of the required jet pump, in various materials of construction, are given in the table on page 40.

The diagrams fig. 1 and 2 are valid for a suction medium of air at 20 °C. At other suction temperatures, but at the same suction pressure, the suction flow is calculated according to the following equation:

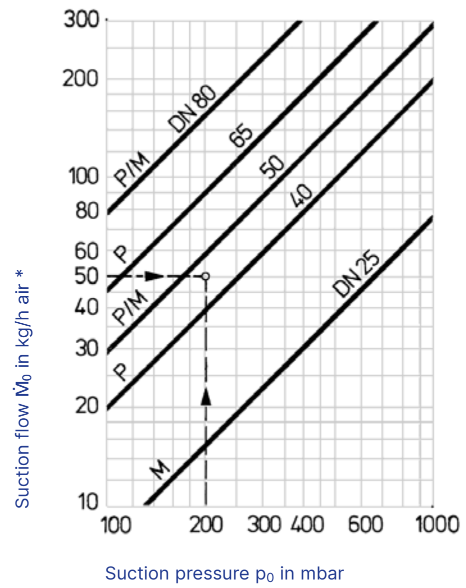
If water vapor, instead of air, is to be drawn off, the suction flow is approx. 80 % of the values given in diagram fig. 2. For other gases or vapors see section “Equivalent suction flows for steam jet vacuum pumps.

Figure 1



Specific steam consumption of a single stage steam jet vacuum pump when compressing to atmosphere (1013 mbar)

Figure 2



M = Metal construction
P = Porcelain construction
*) approx. value dependent on motive steam pressure (10 bar)

Maximum possible suction flow in kg/h for air at 20 °C

Steam jet Ejector as Pre-evacuator

Design example

A vessel with a volume of 31 m³ is to be evacuated from 1000 mbar to 80 mbar in 15 minutes. Motive steam at 10 bar g is available. From fig. 3 for 80 mbar and 10 bar g one finds a specific motive steam consumption of 2.28 kg motive steam/m³ volume to be evacuated.

The steam consumption is then calculated with the aid of the following formula:

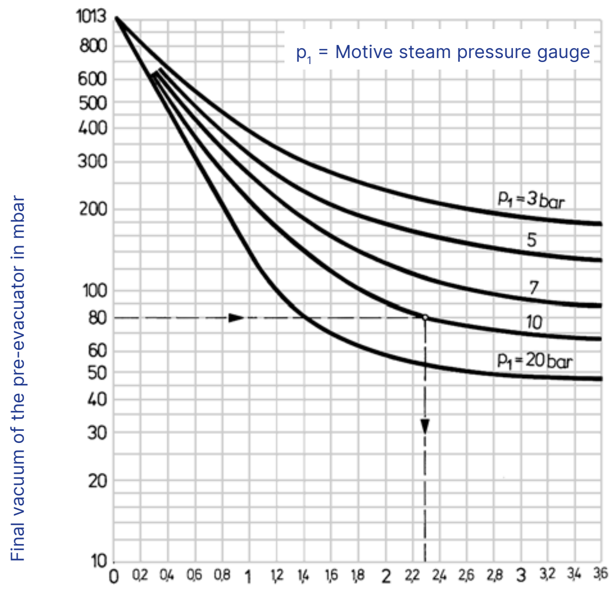
$$\dot{M}_D = D_{spec.} \cdot V \cdot \frac{60}{t}$$

$\dot{M}_D$	Steam consumption in kg/h
$D_{spec.}$	kg motive steam/m³ volume to be evacuated
V	Volume of the plant to be evacuated in m³
t	Required evacuation time in minutes

Fig. 4 gives the nominal diameter of the pre-evacuator required for this steam con- sumption. The example given requires a pre-evacuator DN 80 I.

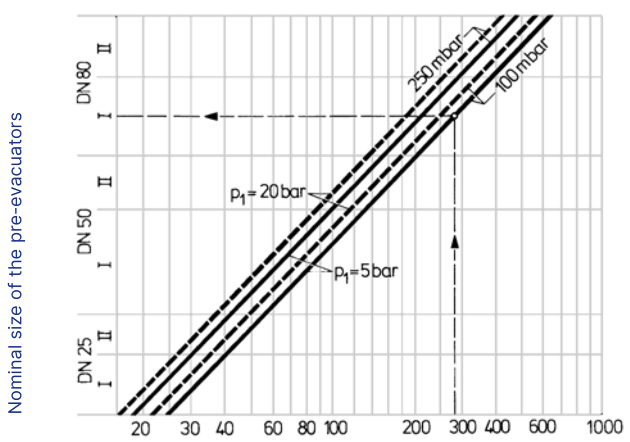
$$\dot{M}_D = 2.28 \cdot 31 \cdot \frac{60}{15} = 283 \frac{kg}{h}$$

Figure 3



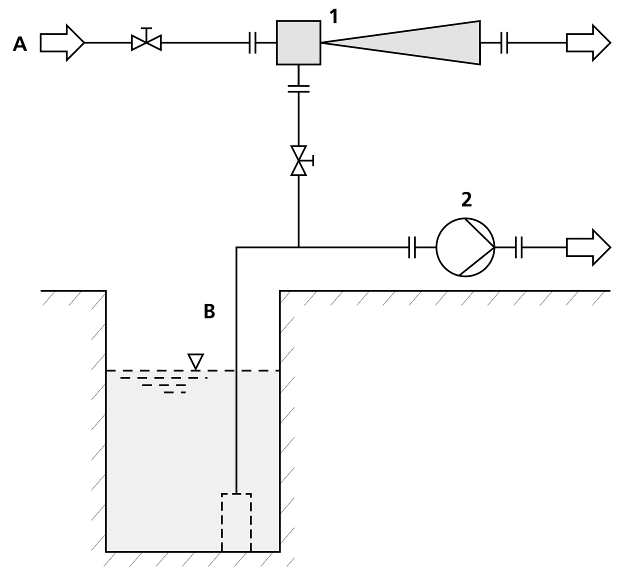
Spec. steam consumption $D_{spec.}$ in kg motive steam/m³ of plant volume to be evacuated

Figure 4



Motive steam consumption in kg/h

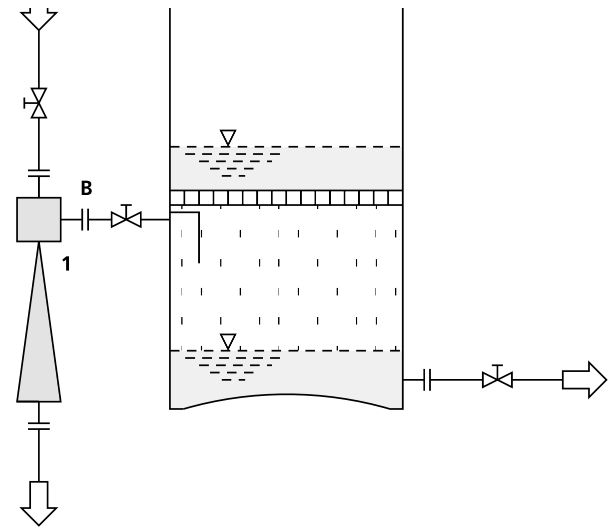
Evacuation of a suction line



Steam jet vacuum pump for evacuating the suction line of a non self-priming pump

1	Steam jet vacuum pump
2	Centrifugal pump
A	Motive steam
B	Suction line

Vacuum production

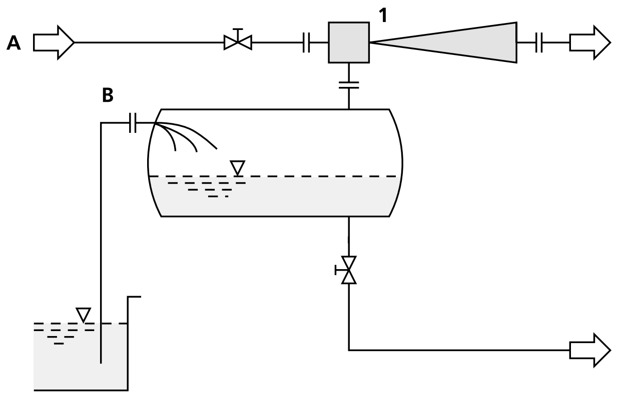


Steam jet vacuum pump for producing a negative pressure in a nutsch filter

1	Steam jet vacuum pump
A	Motive steam
B	Suction line

Lifting of liquids

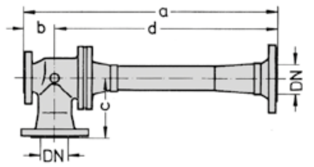
As long as the steam jet pump operates, vacuum is pro- duced and liquid is drawn into the tank. When the steam valve is closed, atmospheric air returns to the tank, the vacuum is broken and lifting stops.



Steam jet vacuum pumps for the lifting of liquids

1	Steam jet vacuum pump
A	Motive steam
B	Suction line

Steam jet vacuum pumps, metal construction



Connections, dimensions and weights

	DN	25	25	50	50	80	80
		I	II	I	II	I	II
Steam connection DN		25	25	25	25	40	40
Dimensions in mm	a	210	300	440	550	750	930
	b	30	30	50	50	90	90
	c	100	100	110	110	175	175
	d	180	270	390	500	660	840
Weight in kg (approx.)		6	7	18	21	43	46

Standard constructions:
I Housing: cast iron EN-GJL-400-15 (GGG40), motive nozzle: stainless steel
II Housing: cast stainless steel (1.4581), motive nozzle: stainless steel
DN 25 und 50: housing and diffusor screwed
DN 80: housing and diffusor flanged, diffusor welded
Flanges according to EN1092-1 or ASME 150 lbs

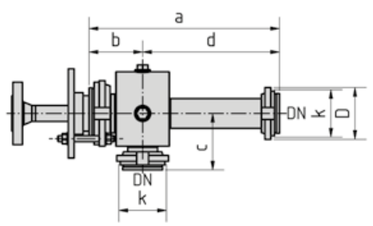
If necessary the steam jet vacuum pumps can also be manufactured in other sizes, constructions and materials and flanges of other nominal pressures and standards can be supplied. This, however, does not apply to pumps of porcelain.

The exact installation dimensions of the pumps depend on the operating conditions. For jet pumps according to the design given in the table, two different dimensions for each size are given.

For large nominal diameters jet pumps are designed in welded construction. The dimensions are adapted to the particular conditions.

Steam jet vacuum pumps, graphite construction

(Replacement for porcelain construction)



Connections, dimensions and weights

	DN	32	40	50	65	80	100	125
Dimensions in mm	a	320	405	510	653	810	1035	1270
	b	90	100	100	130	145	160	170
	c	95	110	110	120	135	150	175
	d	230	305	410	523	665	875	1100
	k	95	120	140	160	185	210	235
	D	115	144	164	188	217	242	267
Weight in kg (approx.)		5	8	11	17	21	40	53

(new construction with flanges acc. to EN1092)	DN	25	50	80	100
Dimensions in mm	a	360	600	985	1320
	b	90	100	145	160
	c	100	110	135	150
	d	270	500	840	1150
Weight in kg (approx.)		5	11	21	40

The motive nozzle connections are not given in the above overview as they depend on the operating conditions.

Standard constructions:
Housing: temperature-change resistant graphite
Motive nozzle: PTFE/GFK
Connection clamps: aluminium cast
Steam connections: steel galvanized

Special constructions: with different connections, nominal pressure stages of the flanges: materials on request.

STEAM JET EJECTOR MULTI POINT OPERATION

(Thermocompressor)

Applications

Steam jet compressors are used in evaporating, distillation, cooling, crystallisation, deodorisation, degassing and drying under vacuum. In the positive pressure range the compressed exhaust vapors are used for heating (heat pump).

Working principle

Steam jet compressors use the energy of a vapor flow $\dot{M}_1$, of a high pressure level p_1 and compress a vapor flow $\dot{M}_0$ of low pressure level p_0 to a medium pressure level p.

Normally, such steam jet compressors are operated by water steam as motive and suction fluid. Basically, however, steam jet compressors can be operated with any vapor.

Performance chart

Fig. 5 shows the relationship between suction flow $\dot{M}_0$, suction pressure p_0 and discharge pressure p at a constant motive steam pressure p_1. If two of the three variables $\dot{M}_0$, p_0 and p are fixed variables on the compressor, the resulting third variable is in accordance with the graph.

The graph has only qualitative validity. The numerical values are only inserted to give a better understanding

Variable flow jet compressor with pneumatic positioner

Adjustment of steam jet compressors

There are various possibilities to adjust steam jet compressors to suit varying operating conditions:

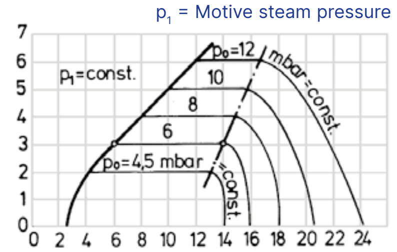
1. Changing the motive nozzle(s)
A limited adaptation of the steam consumption to a varying discharge pressure (e.g. due to a varying cooling water temperature) is possible by altering the motive steam pressure or by changing the motive nozzles.

2. Throttling the motive steam
If a sufficiently high motive steam pressure is available, the steam consumption can be adjusted to suit a varying discharge pressure by throttling. This can be done by hand or by automatic control.

3. Using nozzle needles
The motive flow is changed by reducing the cross section of the motive nozzle by means of a nozzle needle. This is done pneumatically or by electric positioner. Controllable steam jet compressors with spindle nozzles are used for fluctuating suction or mixing flow and constant or varying suction or discharge pressure. The economical use and satisfactory operation of a controllable jet pump is possible for an expansion ratio under 10 up to maximum 20, whereas the expansion ratio E = p_1/p_0.
The steam jet compressor must be designed for the most unfavourable conditions. If the steam jet compressor is not controlled, its steam consumption is always that which is required for the most unfavourable condition. An automatic control takes care that only the amount of steam really required is in fact used.

Figure 5

p_1 = Motive steam pressure

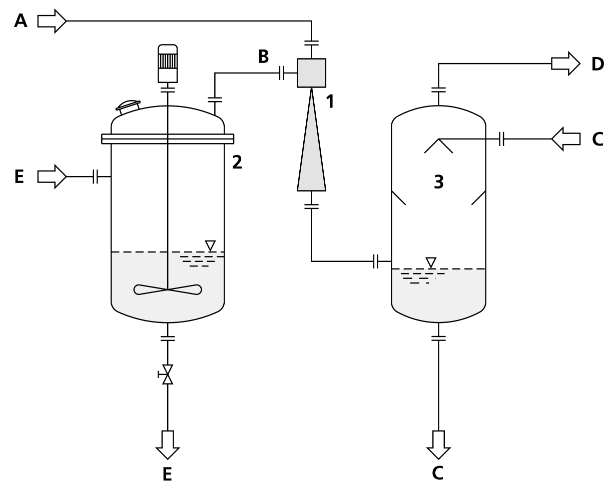


Suction pressure p_0 and discharge pressure p in mbar

The graph has only qualitative validity. The numerical values are only inserted to give a better understanding.

Refrigeration

The boiling of the liquid to be cooled is achieved by using a steam jet compressor to keep a sufficiently low absolute pressure above the liquid.
The special advantage in the crystallisation and cooling of aggressive liquids by this method is that no heat exchange surfaces are required.

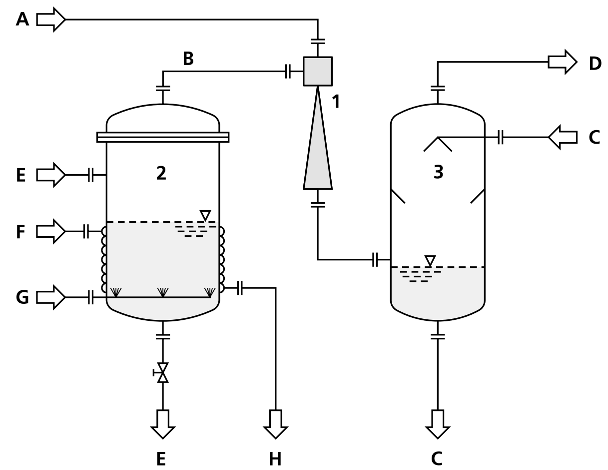


Agitator crystalliser with steam jet compressor for refrigeration

1	Steam jet compressor	A	Motive steam
2	Agitated crystalliser	B	Vapor
3	Mixing condenser	C	Cooling water
		D	To the vacuum pump
		E	Product

Vacuum generation when deodorizing edible OIL

Normally, deodorizing is done by stripping steam at a vacuum of approx. 6 mbar. The steam jet compressor draws off the vapor and compresses it to the pressure in the condenser, e.g. 45 mbar.

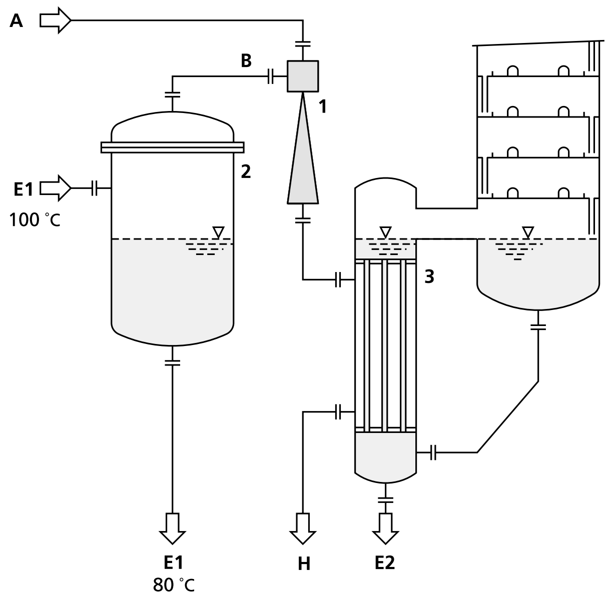


Deodoriser for edible oils with steam jet compressor to increase the vacuum

1	Steam jet compressor	C	Cooling water
2	Tank	D	To the vacuum pump
3	Mixing condenser	E	Product
		F	Heating steam
A	Motive steam	G	Steam
B	Vapor	H	Condensate

Heat recovery

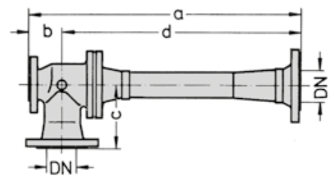
Flashed off vapors are recompressed by a steam jet compressor and used to heat an evaporator in a distillation plant.



Heat recovery from process effluent water by using steam jet compressors as heat pump

1	Steam jet compressor	A	Motive steam
2	Tank	B	Vapor
3	Distillation plant	E1	Product 1
		E2	Product 2
		H	Condensate

Steam jet compressors, metal construction



Connections, dimensions and weights

	DN	25	25	50	50	80	80
		I	II	I	II	I	II
Steam connection DN		25	25	25	25	40	40
Dimensions in mm	a	210	300	440	550	750	930
	b	30	30	50	50	90	90
	c	100	100	110	110	175	175
	d	180	270	390	500	660	840
Weight in kg (approx.)		6	7	18	21	43	46

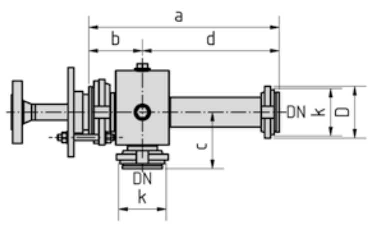
Standard constructions:
I Housing: cast iron EN-GJL-400-15 (GGG40), motive nozzle: stainless steel
II Housing: cast stainless steel (1.4581), motive nozzle: stainless steel
DN 25 und 50: housing and diffusor screwed
DN 80: housing and diffusor flanged, diffusor welded
Flanges according to EN1092-1 or ASME 150 lbs

On request the steam jet compressors can be supplied in other sizes, constructions and materials. Connecting flanges with the requested nominal pressure and according to the required standards can be offered. The exact installation dimensions of the pumps depend on the operating conditions. Thus, the table gives 2 constructions for each different dimension.
For large nominal diameters jet pumps are designed in welded construction. The dimensions are adapted to the particular conditions. The dimensions are given in the quotation on request.

Special constructions: and larger nominal diameters on request. Dimensions, connection dimensions and special performance data on request.

Steam jet compressors, graphite construction

(Replacement for porcelain construction)



Connections, dimensions and weights

	DN	32	40	50	65	80	100	125
Dimensions in mm	a	320	405	510	653	810	1035	1270
	b	90	100	100	130	145	160	170
	c	95	110	110	120	135	150	175
	d	230	305	410	523	665	875	1100
	k	95	120	140	160	185	210	235
	D	115	144	164	188	217	242	267
Weight in kg (approx.)		5	8	11	17	21	40	53

(new construction with flanges acc. to EN1092)	DN	25	50	80	100
Dimensions in mm	a	360	600	985	1320
	b	90	100	145	160
	c	100	110	135	150
	d	270	500	840	1150
Weight in kg (approx.)		5	11	21	40

The motive nozzle connections are not given in the above overview as they depend on the operating conditions.

Standard constructions:
Housing: temperature-change resistant graphite
Motive nozzle: PTFE/GFK
Connection clamps: aluminium cast
Steam connections: steel galvanized

Special constructions: with different connections, nominal pressure stages of the flanges: materials on request.

For inquiries please use our questionnaire.

STEAM JET EJECTORS OPERATING AS VENTILATORS

(Thermocompressor)

Applications

Steam jet ventilators convey air, gases and vapors against small pressure differences up to approximately 500 mbar and are used, e.g.:

- to draw of waste air, exhaust gases and vapor
- to ventilate tanks
- as forced blast blowers, or stack ventilators for boiler burners
- to extract and mix exhaust gases from the thermal afterburning

Instead of steam, it is also possible to use compressed air or another gas as motive fluid for jet ventilators.

The achievable pressure difference between the suction pressure and discharge pressure is the compression of the steam jet ventilator.

Working principle

Steam jet compressors use the energy of a vapor flow $\dot{M}_1$, of a high pressure level p_1 and compress a vapor flow $\dot{M}_0$ of low pressure level p_0 to a medium pressure level p. Normally, such steam jet compressors are operated by water steam as motive and suction fluid. Basically, however, steam jet compressors can be operated with any vapor. Steam jet compressors use the energy of a vapor flow Ø1, of a high pressure level p_1 and compress a vapor flow Ø0 of low pressure level p_0 to a medium pressure level p. Normally, such steam jet compressors are operated by water steam as motive and suction fl uid. Basically, however, steam jet compressors can be operated with any vapor.

In stainless steel

Performance chart

The diagram fig. 6 shows the suction ratio m in kg suction medium per kg motive medium in relation to the compression Δp in mbar, at various motive steam pressures in bar.

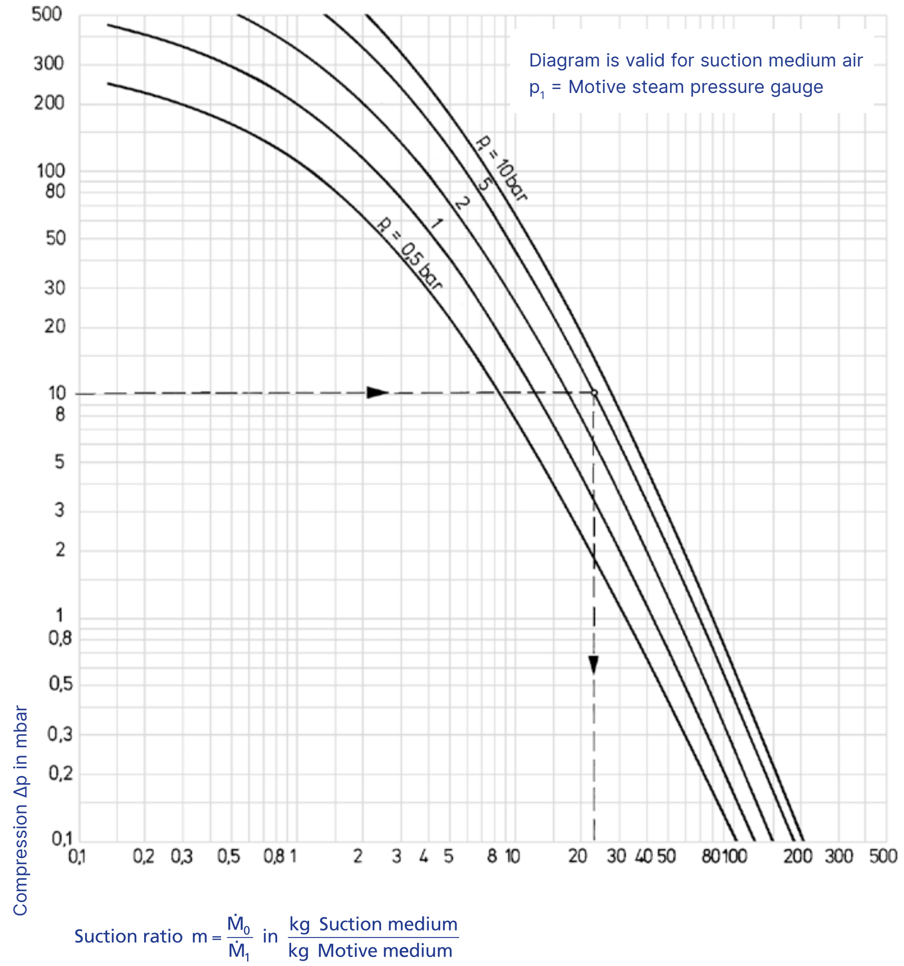
Steam jet ventilators operate in a range between Δp = 0 to 500 mbar.

The motive liquid consumption is calculated by the following equation:

$$\dot{M}_1 = \frac{\dot{M}_0}{m} \text{ in } \frac{kg}{h}$$

$\dot{M}_0$	Suction flow in kg/h
$\dot{M}_1$	Motive medium in kg/h (steam)
m	Suction ratio in kg suction medium/kg motive medium

Figure 6



Design example

Given:
Suction flow 1500 kg/h air
1. Required compression Δp = 10 mbar with motive steam at 5 bar, fig. 6 shows a suction ratio of m = 23.5 kg/kg

$$\text{Steam consumption} = \frac{1500}{23.5} \approx 64 \frac{kg}{h}$$

2. Required compression Δp ~ 0 mbar with motive steam at 5 bar, fig. 6 shows a suction ratio of m = ca. 190 kg/kg.

$$\text{Steam consumption} = \frac{1500}{190} \approx 8 \frac{kg}{h}$$

STEAM JET LIQUID PUMPS

Applications

Liquid jet liquid pumps are used for conveying and mixing liquids. **Elevating and conveying** of liquid chemicals such as lyes, acids, tanning liquors, lime milk, effluent water, spent wash, mash, bilge water, etc.
Circulating with simultaneous heating of the liquid contents.

Working principle

In compliance with the varying demands, two different classes of standard steam liquid pumps are constructed:
1. Class A
for low suction heights, up to max. 1 m (where, density, ρ = 1000 kg/m³ or liquid feed) and large discharge pressures
2. Class B
for larger suction heights and discharge pressures up to approx. 1.1 bar g

In addition to the standard pumps, we supply special constructions for larger suction heights and discharge pressures.

In steel

In stainless steel

Special construction for the nuclear industry in stainless steel

Class A

Performance chart

Steam jet liquid pumps class A are suitable for low suction heights, up to max. 1 m (where, density, ρ = 1000 kg/m³ or for liquid feed) and large discharge pressure.

Design example

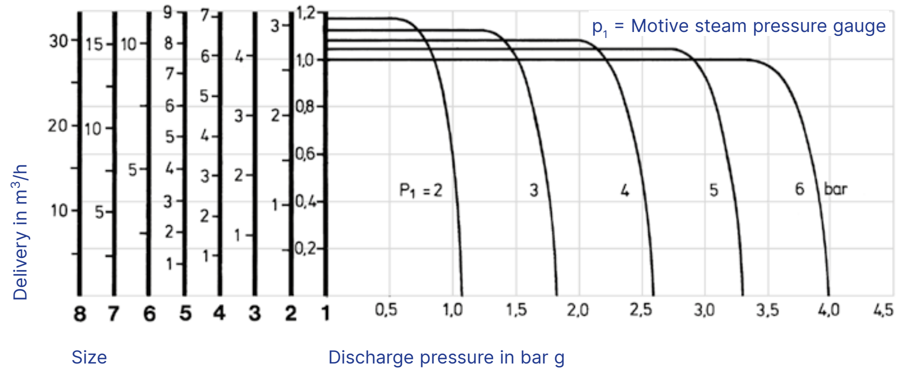
6 m³/h of water is to be drawn at a suction height of 1 m and conveyed to a discharge pressure of 1.6 bar g. A motive steam pressure of 3 bar g is available.

Parameters to be found:
Pump size and motive steam consumption.

Solution:
The diagram fig. 7 shows that for a discharge pressure of 1.6 bar g and a motive steam pressure of 3 bar g in relation to the delivery of 6 m³/h, a pump size 5 has to be used.

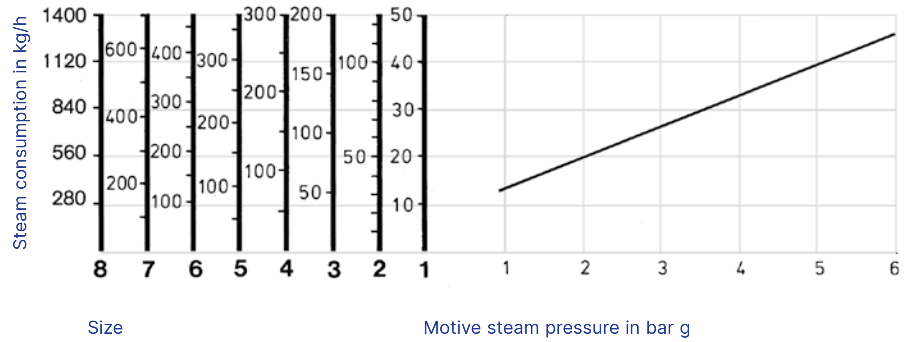
Fig. 8 shows a steam consumption of approx. 190 kg/h for the chosen size.

Figure 7

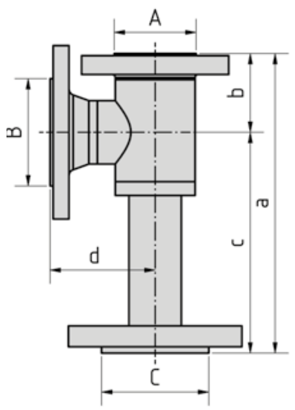


Delivery in m³/h of water at a suction height of approximately 1 m in relation to the discharge pressure at varying motive steam pressures p_1.
Size 1 achieves only 65-70 % of the given discharge pressures.

Figure 8



Steam consumption in kg/h of the individual sizes in relation to the motive steam pressure.



Connections, dimensions and weights

	Size	1	2	3	4	5	6	7	8
Motive steam connection	A	15	20	25	25	32	32	40	50
Suction connection	B	20	25	32	40	50	50	65	80
Pressure connection	C	20	25	32	40	50	50	65	80
	a	130	190	205	235	285	285	380	460
	b	50	60	60	70	75	75	95	110
	c	70	80	85	85	100	100	120	125
	d	80	130	145	165	210	210	285	350
Weight in kg (approx.)		4	6	8	10	12	12	19	27

Standard constructions:
I Housing: steel, motive nozzle: brass (2.1090)
II Housing: steel, motive nozzle: stainless steel (1.4571)
III Housing: stainless steel (1.4571), motive nozzle: stainless steel (1.4571)
Flanges according to EN1092-1/PN 16/PN 40

Special constructions for other capacity data or materials such as stainless steel, Hastelloy, Titanium, etc. on request.

Special constructions for the nuclear industry are supplied in welded construction according to the special test and acceptance conditions.

Dimensions, connections and special capacity data on request.

Class B

Performance chart

Steam jet liquid pumps class B are constructed for suction heights larger than 1 m and discharge pressure up to approximately 1.1 bar g.

Design example

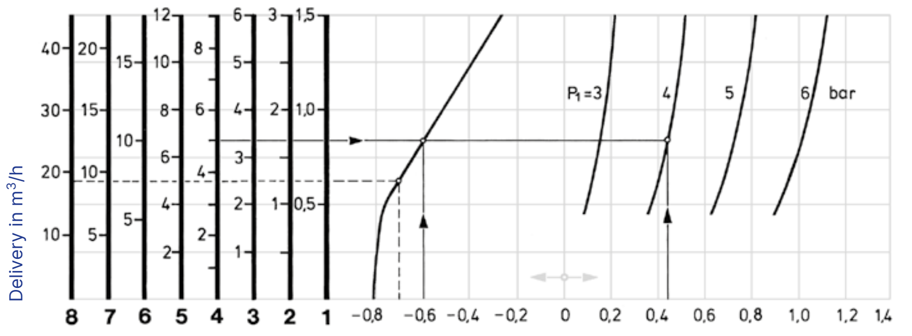
5 m³/h of water is to be drawn from a manometric suction pressure of –0.6 bar and conveyed to a discharge pressure of 0.45 bar g.

Parameters to be found:
Pump size, motive steam pressure and consumption required.

Solution:
The delivery and the suction pressure determine the size of the pump whilst the discharge pressure determines the motive steam pressure required.
The example in fig. 9 gives a size 4 pump and a motive steam pressure of 4 bar.

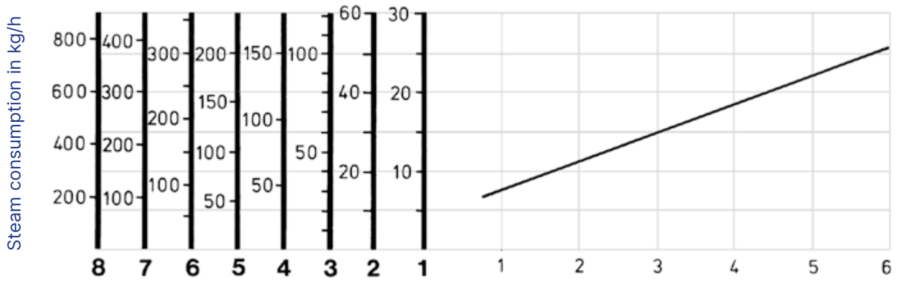
The steam consumption of 110 kg/h is found in diagram fig. 10.

Figure 9



Delivery in m³/h of water at a temperature of 20 °C, depending on the suction and discharge pressure (limit discharge pressure) at different motive steam pressures p_1

Figure 10



Steam consumption in kg/h of the individual sizes in relation to the motive steam pressure

STEAM JET HEATERS

Applications

Steam jet heaters are used to prepare hot water for different purposes, such as barrel rinsing water in malting plants, warm water for pickling, dyeing, and greases in tanneries, for washrooms and bathrooms and for heating sewage sludge, boiling lyes etc.

Working principle

Steam jet heaters are used to heat liquids by direct injection of heating steam. The heating steam condensate mixes with the liquid being heated.

There are generally 2 different construction forms, according to the application
- steam jet heaters for vessels
- steam jet heaters for installation in pipes

and for passage and circulation heating systems: Type “L”, Type “H”, “System CibaGeig

For vessels with threaded connection, in cast stainless steel

For pipelines, in steel

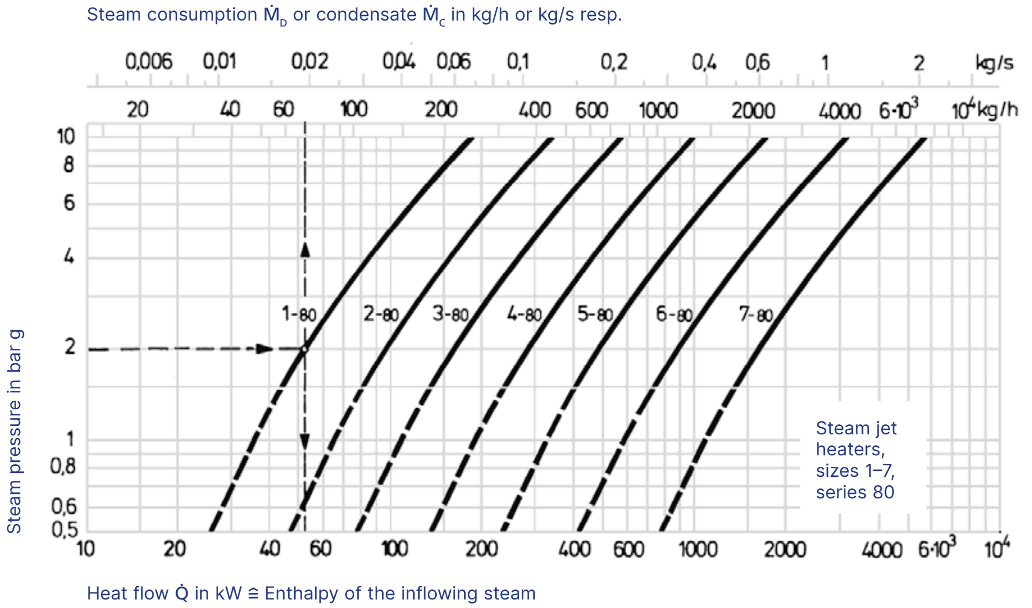
For circulation, in steel

"System Ciba-Geigy" in cast iron

Steam jet heaters (Vessels)

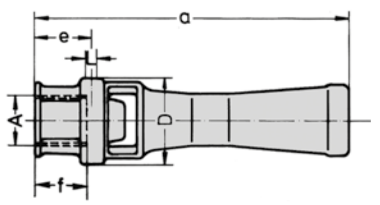
Steam jet heaters are used to heat all kinds of liquids in vessels. Heating is achieved by means of direct condensation of steam. The steam condensate mixes with the liquid.The material to be conveyed flows

Figure 11



Performance chart for steam jet heaters, size 1 to 7, construction series 80, for water

Steam jet heater type 18.1, with thread



Connections, dimensions and weights

	Size	1-80	2-80	3-80	4-80	5-80	6-80	7-80
Nominal diameter	A	G 3/4	G 1	G 1 1/2	G 1 1/2	G 2	G 3	G 4
	L	G 1/8	G 1/8	G 1/4	G 1/4	G 1/4	G 3/8	G 3/8
Dimensions in mm	a	170	220	265	345	400	520	610
	D	52	60	75	85	100	125	160
	e	35	40	40	40	50	75	80
	f	20	25	24	24	30	33	40
Weight in kg (approx.)		1	2.6	2.8	4.2	6.4	13	23

Standard constructions:
I Housing: cast iron EN-GJL-200 (GG20), motive nozzle: stainless steel
II Housing: cast stainless steel (1.4581), motive nozzle: stainless steel
Thread according to DIN ISO 228

Special constructions: other capacities or materials e. g. Hastelloy, Titan and more on request.

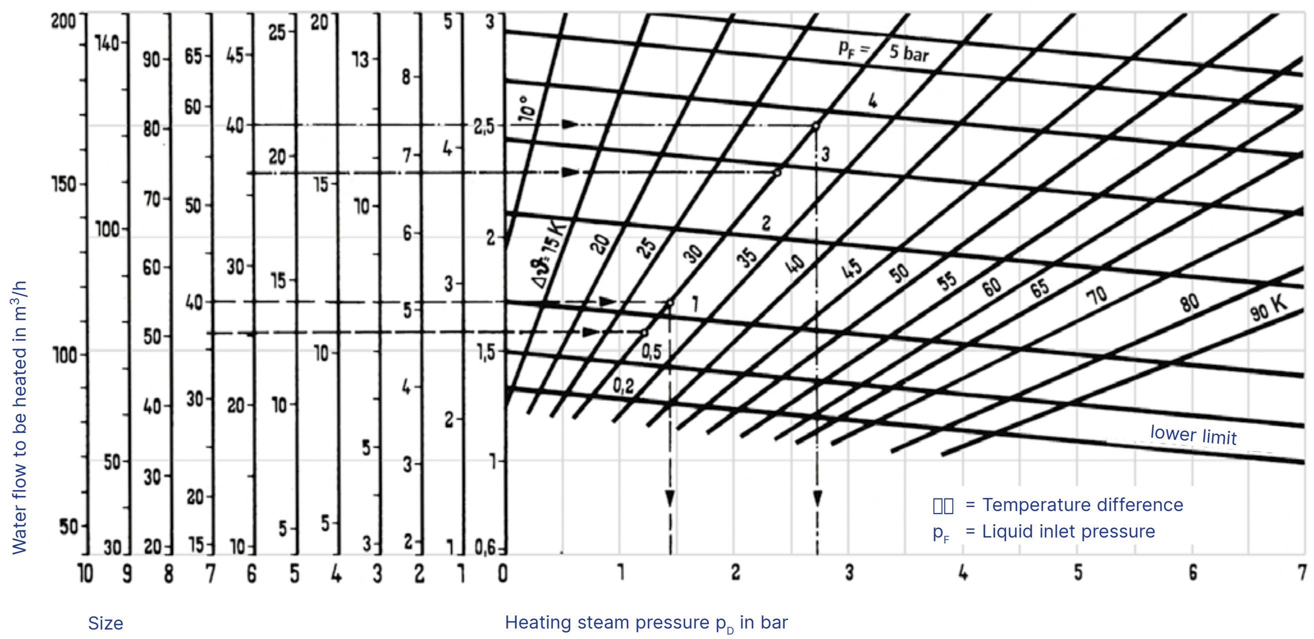
Please indicate size, type and material with your order.
For inquiries please use our questionnaire.

Steam jet heaters (Pipelines)

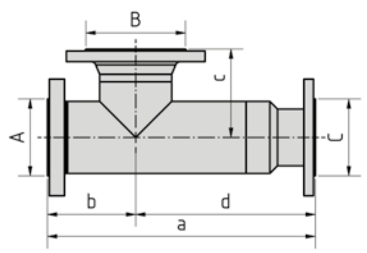
Steam jet heaters are used to heat liquids by means of direct condensation of steam. The steam condensate mixes with the liquid. Steam jet heaters, type “L” are used in pas- sage and circulation heating systems.

The achievable heating per pass amounts to max. 90 K.

Figure 12



The performance chart fig. 12 shows to which temperature a liquid can be heated, depending on the liquid flow and on the steam pressure at an inlet temperature of 20 °C



Connections, dimensions and weights

	Size	0	1	2	3	4	5	6	7	8	9	10
Nominal diameter	A	25	32	40	50	65	65	80	100	125	150	150
	B	32	40	50	65	80	100	125	150	200	200	250
	C	25	32	40	50	65	65	80	100	125	150	150
Dimensions in mm	a	230	265	310	350	380	425	650	890	975	1275	1275
	b	70	85	100	110	125	140	200	345	365	515	515
	c	85	100	105	120	130	140	175	200	200	200	200
	d	160	180	210	240	255	285	450	545	610	760	760
Weight in kg (approx.)		7	9	12	15	21	23	34	51	60	72	90

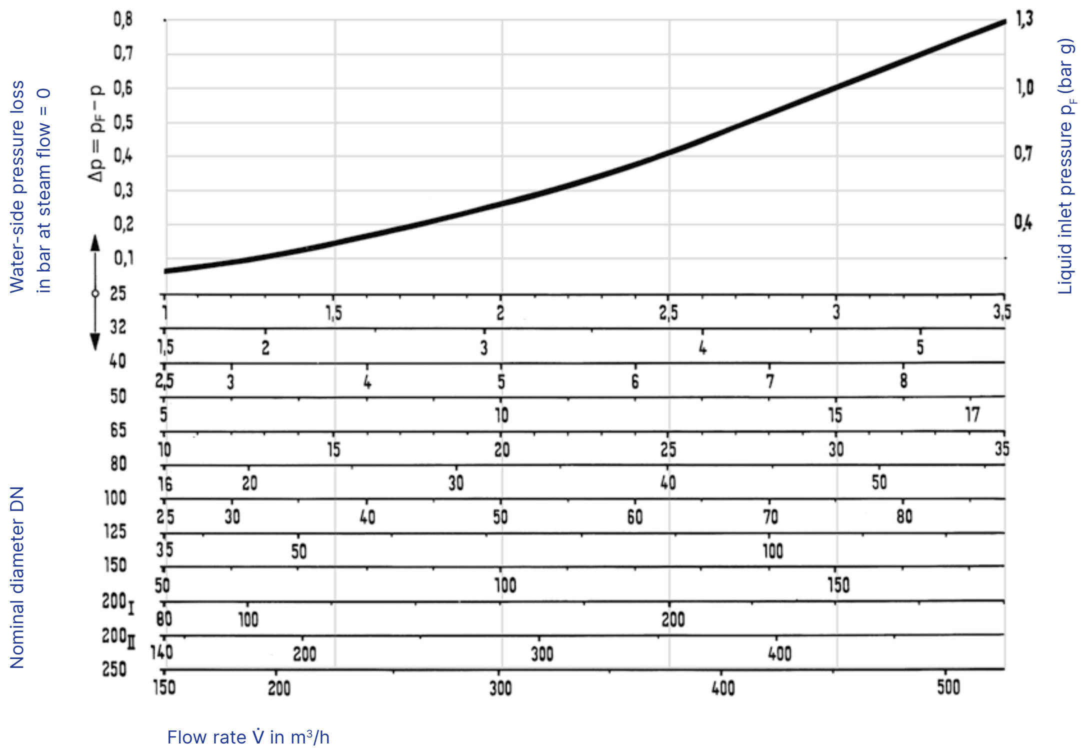
Standard constructions:
I Housing: steel, condensation nozzle: red brass
II Housing: steel, condensation nozzle: stainless steel (1.4571)
III Housing: stainless steel (1.4571), condensation nozzle: stainless steel (1.4571)
Flanges: EN1092-1 PN 16

Special constructions: other capacities or materials e. g. Hastelloy, Titan and more on request.
For inquiries please use our questionnaire.

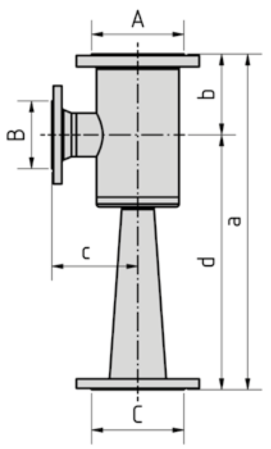
Steam jet heaters (Circulation)

Steam jet heaters are used to heat all kinds of liquids in vessels. Heating is achieved by means of direct condensation of steam. The steam condensate mixes with the liquid.The material to be conveyed flows.

Figure 13



Relation between flow rate, heating and steam consumption



Connections, dimensions and weights

	Size	25	32	40	50	65	80	100	125	150	200 I	200 II	250
Nominal	A	25	32	40	50	65	80	100	125	150	200	200	250
diameter	B	32	40	32	40	50	65	65	80	100	150	150	200
	C	25	32	40	50	65	80	100	125	150	200	200	250
Dimensions	a	230	265	260	280	350	450	500	685	750	1000	1050	1400
in mm	b	70	85	70	80	80	115	100	165	165	200	200	250
	c	85	100	115	125	125	135	135	175	200	200	200	250
	d	160	180	190	200	270	335	400	520	585	800	850	1150
Weight in kg (approx.)		7	9	10	14	23	24	30	38	44	71	77	112

Standard constructions:
DN 125 to DN 250:
I Housing: steel, condensation nozzle: red brass
II Housing: steel, condensation nozzle: stainless steel (1.4571)
III Housing: stainless steel (1.4571), condensation nozzle: stainless steel (1.4571)
Flanges according to EN1092-1 PN 16

Special constructions: are possible in most of the usual materials.

For inquiries please use our questionnaire.

Steam jet heaters ("System Ciba-Geigy")

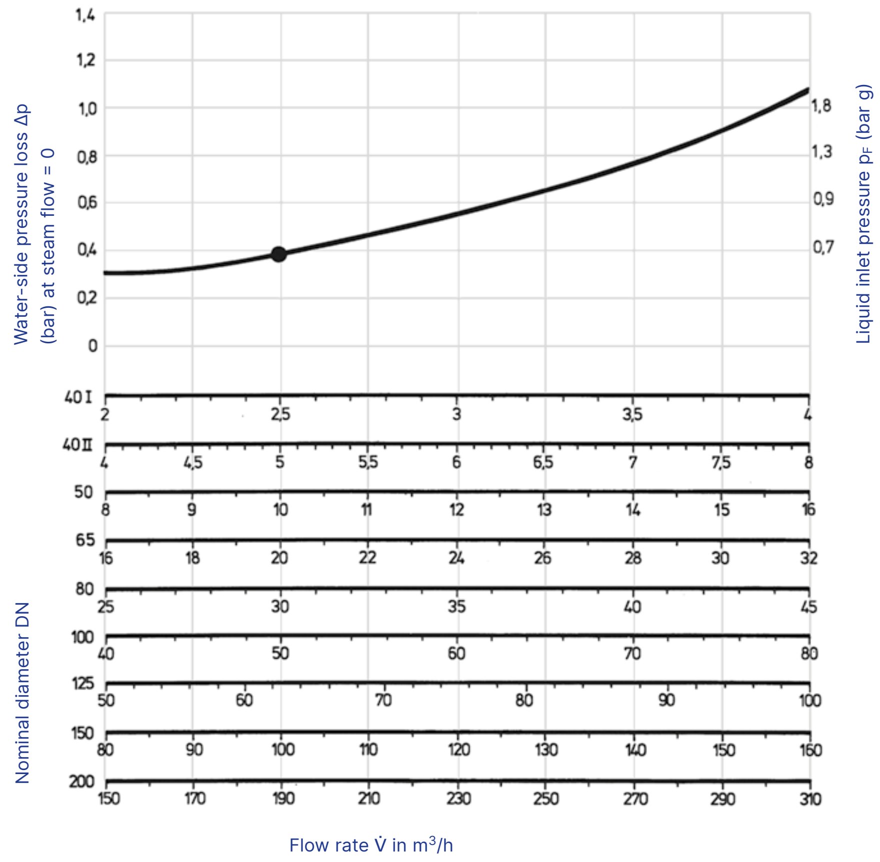
Figure 14

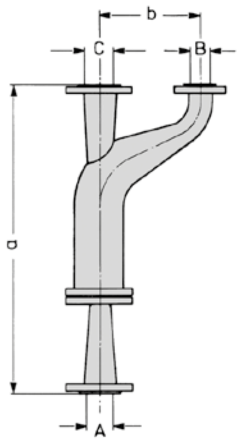
Steam jet heaters are used to directly heat a liquid with heating steam.

Steam jet heaters, "System Ciba Geigy", are used in passage and circulating heating systems and for batch processes:

Heating processes rarely require a constant heating capacity. Normally the steam flow is ajusted to the required operating conditions, by means of a temperature control circuit.

- flow rates of 2–700 m³/h
- heating per pass up to approx. 30 K
- control range of heating capacity up to 200:1
- heating up to approx. 5 °C below the saturated steam temperature of the heating steam





Connections, dimensions and weights

	Size	40 I	40 II	50	65	80	100	125	150	200
Nominal diameter	A	40	40	50	65	80	100	125	150	200
	B	40	40	40	50	65	65	80	100	150
	C	40	40	50	65	80	100	125	150	200
Dimensions in mm	a	450	450	500	630	800	900	1120	1300	1700
	b	158	158	188	205	217	250	305	400	535
Weight in kg (approx.)		23	23	30	42	35	46	66	104	186

Standard constructions:
DN 40 to 65:
I Housing: cast iron EN-GJS-400-18-LT (GGG40.3), condensation nozzle: brass
II Housing: cast iron EN-GJS-400-18-LT (GGG40.3), condensation nozzle: stainless steel (1.4571)

DN 40 to 200:
III Housing: steel, condensation nozzle: brass
IV Housing: steel, condensation nozzle: stainless steel (1.4571)
V Housing: stainless steel (1.4571), condensation nozzle: stainless steel (1.4571)
Flanges EN1092-1 PN 16

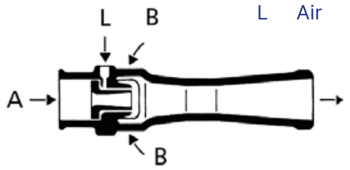
Special constructions: other capacities or materials e.g. Hastelloy, Titan and more on request.
For inquiries please use our questionnaire.

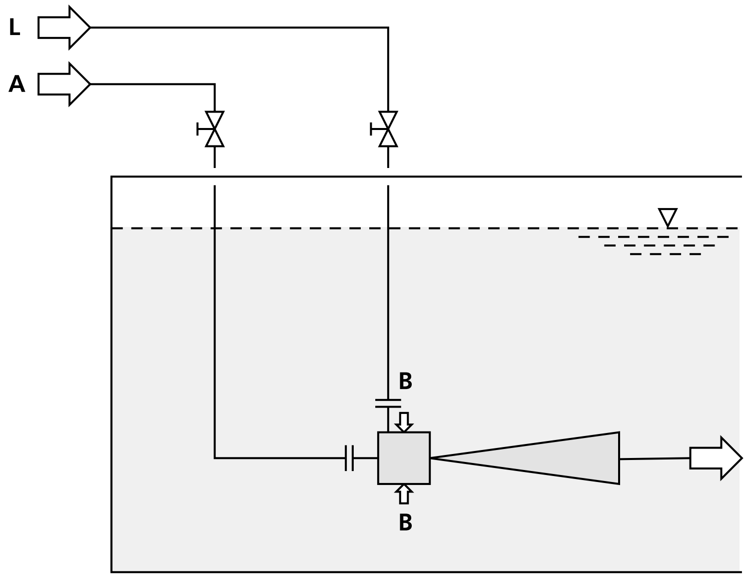
Examples of installation

Steam jet heater type 18.1, with thread

Steam jet heater type 18.1, with thread

A Motive steam
B Liquid
L Air

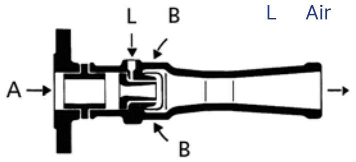


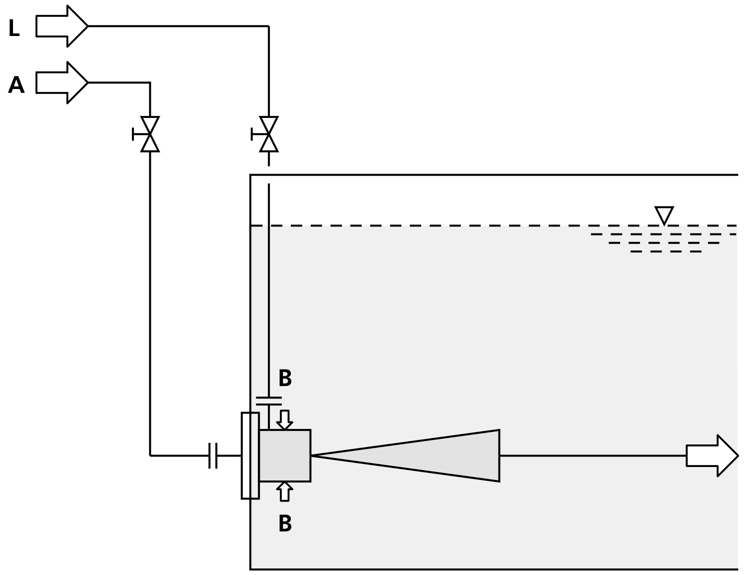


Steam jet heater type 28.1, with flange

Steam jet heater type 28.1, with flange

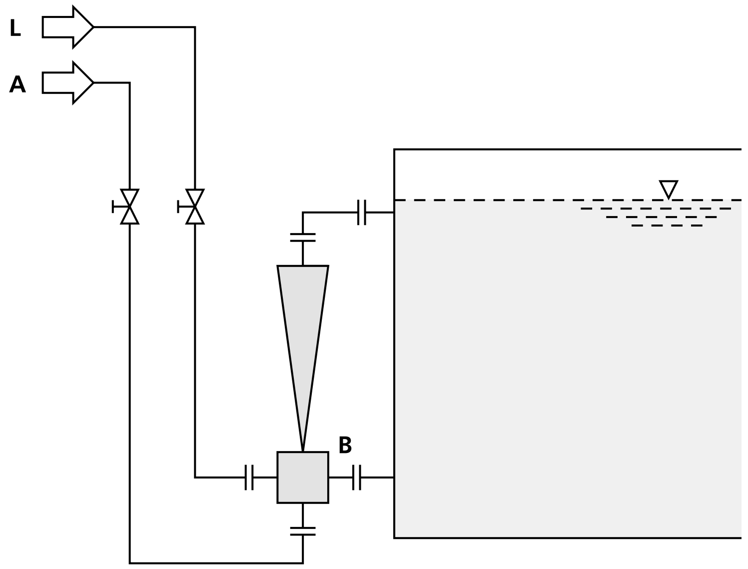
A Motive steam
B Liquid
L Air

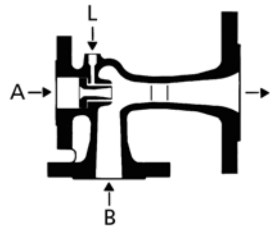




Steam jet heater with housing, Type 38.1

Special constructions designed according to the customer's specification





A Motive steam
B Liquid
L Air

Steam jet heaters, type 38.1 must only be used for a liquid level of min. 0.5 m above the heater.

Dimensions, connection dimensions, materials and special capacity data on request.

GAS JET EJECTORS

Applications

Gas jet ejectors are used in many cases to evacuate pipelines, vessels and plants.

Working principle

Gas jet ejectors operate on the same principle as all jet pumps: The pressure energy of the motive medium is converted into speed energy in the motive nozzle. Instead of liquid or steam, gas or compressed air is used as motive medium.

In stainless steel

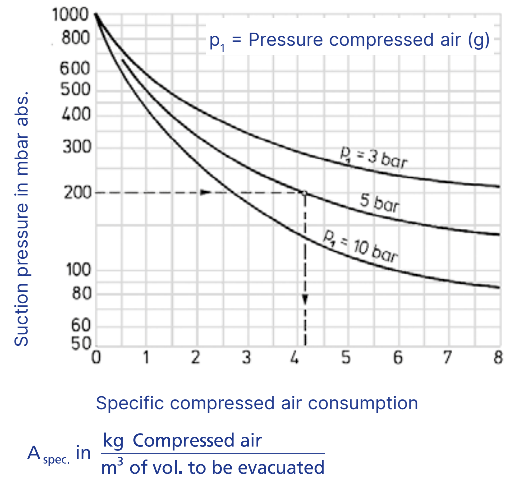
For the nuclear industry, in stainless steel

GAS JET COMPRESSORS

Applications

Gas Jet compressors are mainly used to mix and compress gases.

Figure 1



Working principle

The compressed air consumption required is found in relation to the evacuating apparatus volume according to the following formula

$$\dot{M}_A \approx A_{spec.} \cdot V \cdot \frac{60}{t}$$

$\dot{M}_A$	Compressed air consumption in kg/h
$A_{spec.}$	Specific compressed air consumption in kg compressed air/m³ of volume to be evacuated (Fig. 1)
V	Vessel volume to be evacuated
t	Evacuation time in minutes

Design example

A vessel of 2 m³ is to be evacuated from atmospheric pressure to 200 mbar in 10 minutes. A compressed air pressure of 5 bar is available.

From fig. 1, you will find a specific air consumption of 4.15 kg of compressed air/m³ of volume to be evacuated. The compressed air consumption is, therefore

$$\dot{M}_A \approx 4.15 \cdot 2 \cdot \frac{60}{10} \approx 50 \frac{kg}{h}$$

For the natural gas industry

GAS JET VENTILATORS

Applications

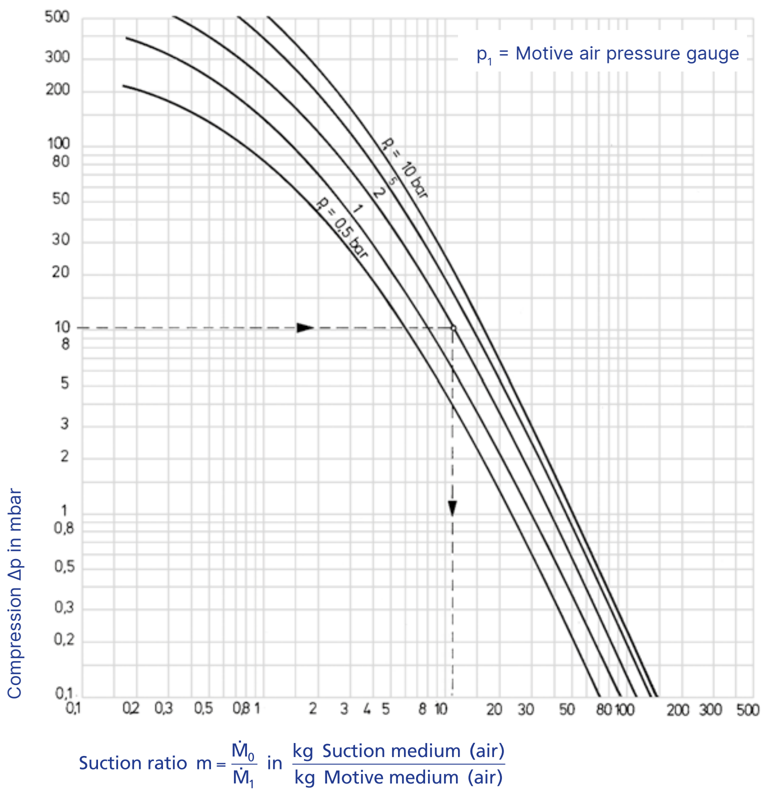
Gas jet ventilators convey air, gases and vapors against pressure diff erences up to approximately 500 mbar.

Gas jet ventilators are used:

- to draw off stale air, ill-smelling gases and vapors from working and storage areas
- to ventilate tanks, e.g. on ships
- as forced blast blowers or stack ventilators for boiler burners
- for the circulation of air, in particular in the textile, leather and tobacco industries
- to deaerate reaction vessels, agitator vessels and other items of equipment in chemical factories

The achievable pressure diff erence between the suction and discharge pressure is the compression of a gas jet ventilator

Figure 2



In stainless steel

In stainless steel

In stainless steel

AIR JET EJECTORS

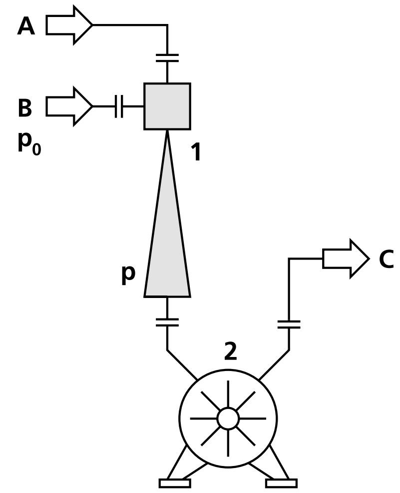
Applications

Air jet vacuum pumps use atmospheric air as motive medium. Backed by a liquid ring vacuum pump which produces an intermediate vacuum of 50 to 100 mbar, the air jet vacuum pump can reach a suction pressure of 5 mbar, depending on design and operating conditions.

- When no steam is available as motive medium for a steam jet vacuum pump required to produce a vacuum of 40 to 5 mbar.
- When a liquid ring pump is available with a suction capacity sufficient to handle the motive air of the air jet pump and when a suction pressure below 40 mbar is to be produced.
- produced and simple installation with low capital cost is important.
- When only a small suction capacity at a suction pressure of 40 to 50 mbar is required and cooling water at low temperature is available, because under these circumstances, the power consumption of the liquid ring vacuum pump is relatively low.

Whenever it is a question of low energy consumption, it is better to connect a steam jet pump with condenser to the suction side of the liquid ring vacuum pump, whereby the motive medium (steam) of the jet pump is condensed and does not load the liquid ring vacuum pump as is the case with an air jet pump.

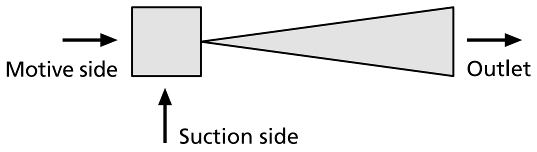
Figure 3



1	Air jet vacuum pump
2	Liquid ring vacuum pump
A	Atmospheric air as motive medium
B	Suction medium
C	Atmosphere
p_0	Suction pressure
p	Discharge pressure of the air jet vacuum pump = Suction pressure of the liquid ring vacuum pump

Method of operation of an air jet vacuum pump for connection to the suction side of a liquid ring vacuum pump

Questionaire for liquid ejectors



Batch Process

Continious Process

1. Motive side

Motive medium ....

Motive flow .... m³/h

Motive pressure .... bar abs.

Temperature .... °C

Density .... kg/m³

Concentration .... weight %

Steam pressure .... bar abs.

2. Suction side

Suction medium ....

Suction flow .... m³/h

Suction pressure .... bar abs.

Temperature .... °C

Density .... kg/m³

Concentration .... weight %

Dyn. viscosity .... mPas

3. Outlet

Required discharge pressure .... bar abs.

Mixed flow .... kg/h

Concentration .... weight %

4. Brief description

Process purpose:

....

....

5. Further data

Material of construction ....

Connections:

Flanges

Thread

Others

Flanges according to:

EN1092-1

ASME lbs

Others

Design code (if required):

AD-2000

ASME

Others

Application:

....

....

....

Design:

Temperature .... °C

Pressure .... bar g

Additional details, if required, are to be stated separately.

Your inquiry no. ....

Offer submitted until ....

Requested date of delivery ....

Your address

Company ....

attn. ....

Street/P.O. Box ....

ZIP code/City ....

Country ....

Telephone ....

Telefax ....

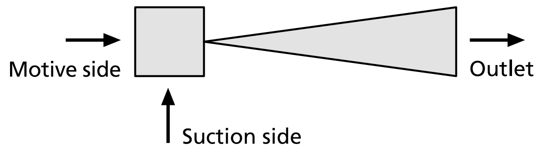
E-mail ....

GEA Engineering for a better world.

GEA Wiegand GmbH
Am Hardtwald 1, 76275 Ettlingen, Germany

Tel. +49 7243 705-0
chemical@gea.com, gea.com

Questionaire for steam ejectors



Batch Process

Continious Process

1. Motive side

Motive medium ....

Motive pressure .... bar abs.

Temperature .... °C

Molecular weight .... kg/kmol

Specific heat capacity .... kJ/kg K

2. Suction side

Suction medium ....

Suction flow .... kg/h

Suction pressure .... bar abs.

Steam pressure .... bar abs.

Temperature .... °C

Molecular weight .... kg/kmol

Specific heat capacity .... kJ/kg

Density .... kg/m³

3. Outlet

Required discharge pressure .... bar abs.

Mixed flow .... kg/h

4. Brief description

Process purpose:

....

....

5. Further data

Material of construction ....

Connections:

Flanges

Thread

Others

Flanges according to:

EN1092-1

ASME lbs

Others

Design code (if required):

AD-2000

ASME

Others

Application:

....

....

....

Design:

Temperature .... °C

Pressure .... bar g

Additional details, if required, are to be stated separately.

Your inquiry no. ....

Offer submitted until ....

Requested date of delivery ....

Your address

Company ....

attn. ....

Street/P.O. Box ....

ZIP code/City ....

Country ....

Telephone ....

Telefax ....

E-mail ....

GEA Engineering for a better world.

GEA Wiegand GmbH
Am Hardtwald 1, 76275 Ettlingen, Germany

Tel. +49 7243 705-0
chemical@gea.com, gea.com