Wiegand® Evaporation Technology for the Concentration of Glycerine Water

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GEA Process Engineering

Evaporation technology for the concentration of glycerine water

Glycerine, also referred to as propantriol, is a trivalent alcohol which due to its special properties is used in many sectors of industry as lubricant, solvent, plasticisers and humidity stabilisers.

Properties of glycerine

- Unlimited miscibility with water and alcohols
- Low freezing point of glycerine-water mixtures of, e.g. -46.5 °C at 66.7 weight %
- Thermal stability up to 180 °C
- Non-toxic
- Colourless and odourless
- Strongly hygroscopic

Production of glycerine

Glycerine can be produced by saponification or hydrolysis of natural fats and oils, by fermentation of sugar, by hydrogenation and cracking of carbohydrates or synthetically of propylene.

The hydrolysis of animal and vegetable fats and oils (saponification glycerine), the saponification of neutral fats (spent lye glycerine) and, in recent times, the production of bio-diesel by means of esterification of rapeseed oil is of commercial-scale importance.

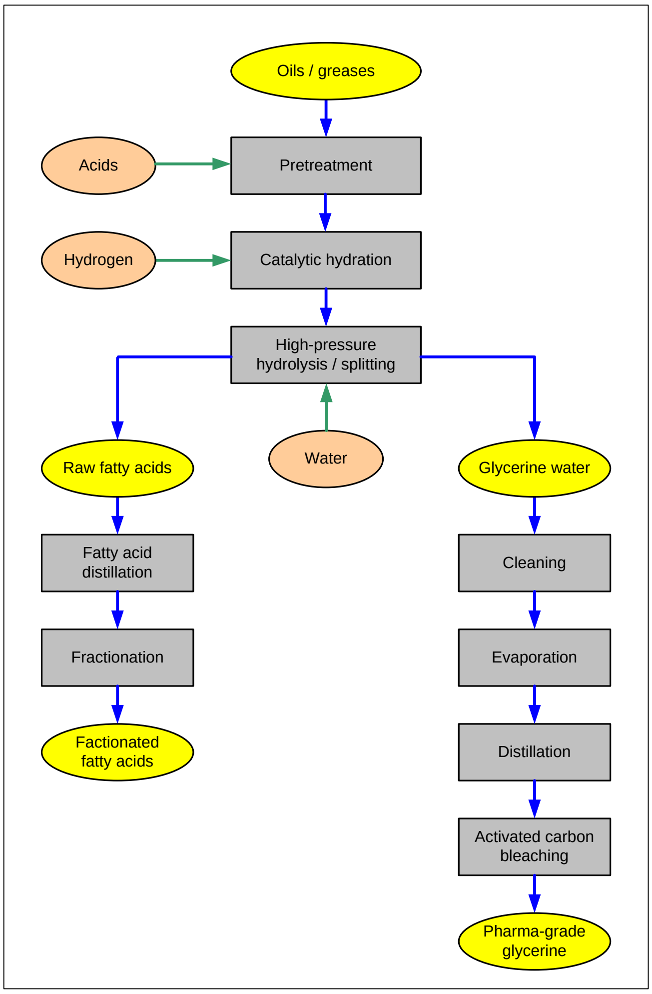


Fig. 1: Production process for glycerine by means of fat splitting (saponification glycerine)

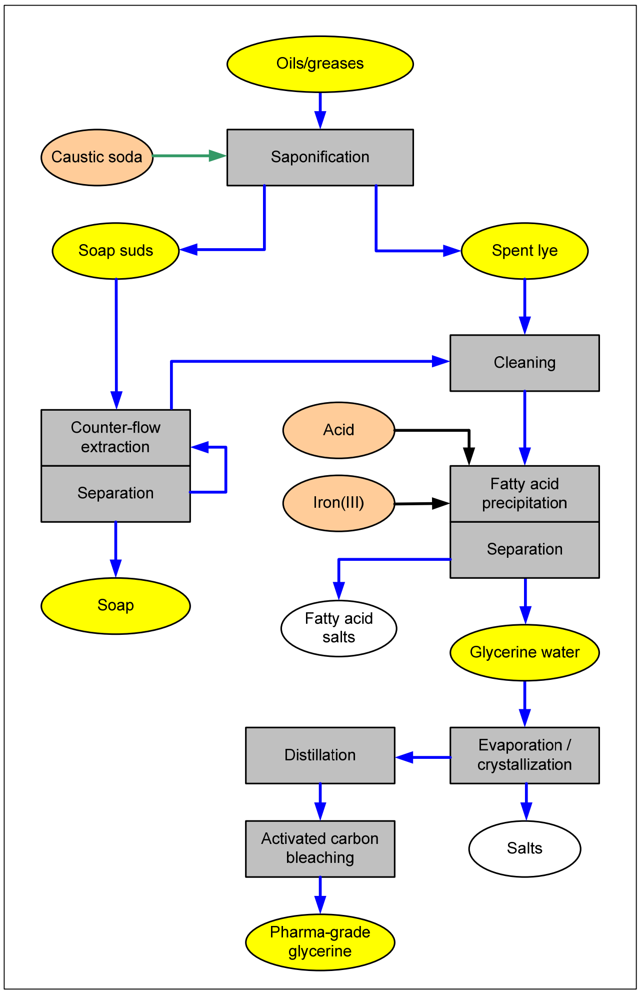


Fig. 2: Production process for glycerine by means of saponification (spent lye glycerine)

Different concentrations and qualities of glycerine are sold. For this reason, the preparation of raw glycerine which - depending on the production process - is produced with 8 - 15 %, has to meet different requirements.

GEA Wiegand has reference plants for the concentration in evaporation systems for all required final concentrations from 86 weight % to 98.8 weight %.

Design of evaporation plants

Numerous information are required and marginal conditions have to be considered to find the optimal solution for the particular and customized operating requirements. The following items are especially important:

- Product-specific properties such as initial concentration and final concentration, type and amount of the contained organic impurities (MONG) and of the salt contents
- Plant efficiency determined by energy costs for steam and electricity, cooling water temperature and investment costs
- Local conditions, such as installation conditions and incorporation into other plant parts

Figure 3 shows that the boiling point elevation of glycerine-water solutions increases very much with increasing concentration. For this reason, the selection of the plant arrangement and of the evaporator type will be extremely important, in particular if the final concentration amounts to more than 80 %.

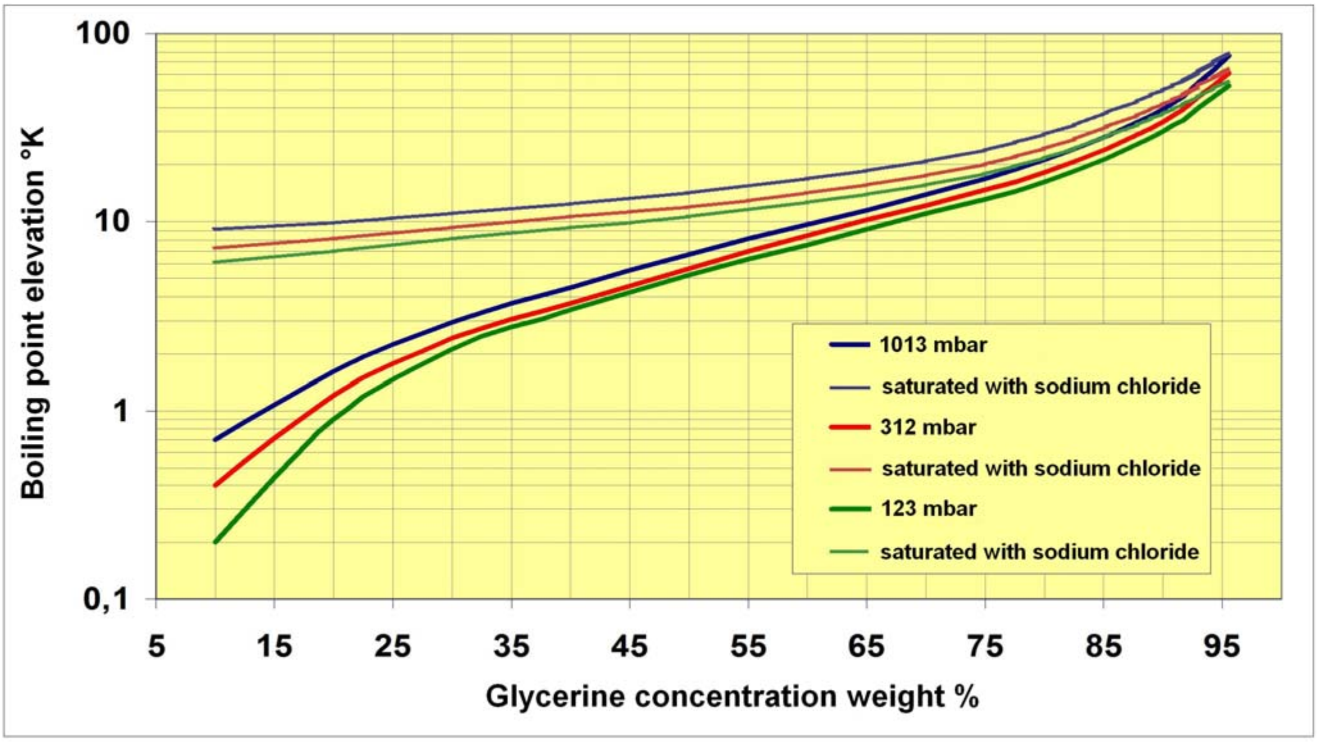


Fig. 3: Boiling point elevation of glycerine-water solutions with and without sodium chloride

For smaller evaporation rates the Wiegand natural circulation evaporator (fig. 4) is frequently used. Its liquid content is smaller, the required construction height is lower and thanks to the fact that circulation pumps are not required it can be operated easily and at very low cost.

For higher concentrations up to approx. 90 % the circulation evaporator with divided boiling chamber (fig. 6) is used in order to save heating surface. The product passes three separate chambers one after the other and for this reason, the concentrations and boiling temperatures are different each time.

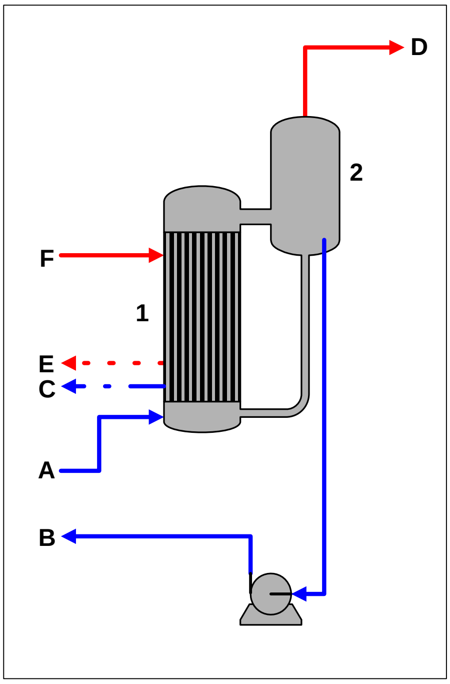


Fig. 4:
Natural circulation evaporator

A	*Product*	*D*	*Vapour*
B	*Concentrate*	*E*	*Ventilation*
C	*Condensate*	*F*	*Steam*
1	*Heating body*		
2	*Separator*		

Fig. 5:
3-effect circulation evaporator
3886 kg/h of water evaporation
for saponification glycerine
Feed 4500 kg/h, 12 % glycerine
Discharge 614 kg/h, 88 % glycerine

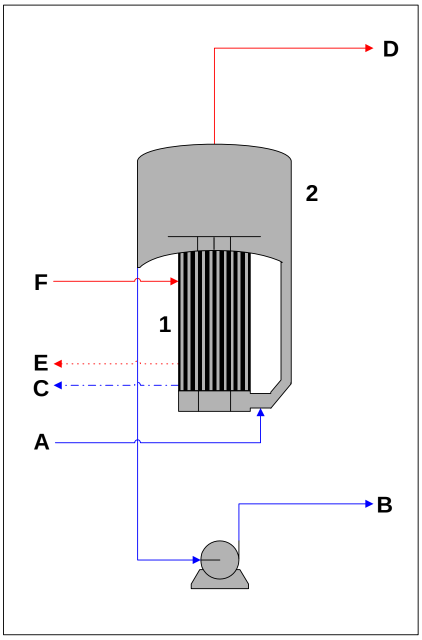
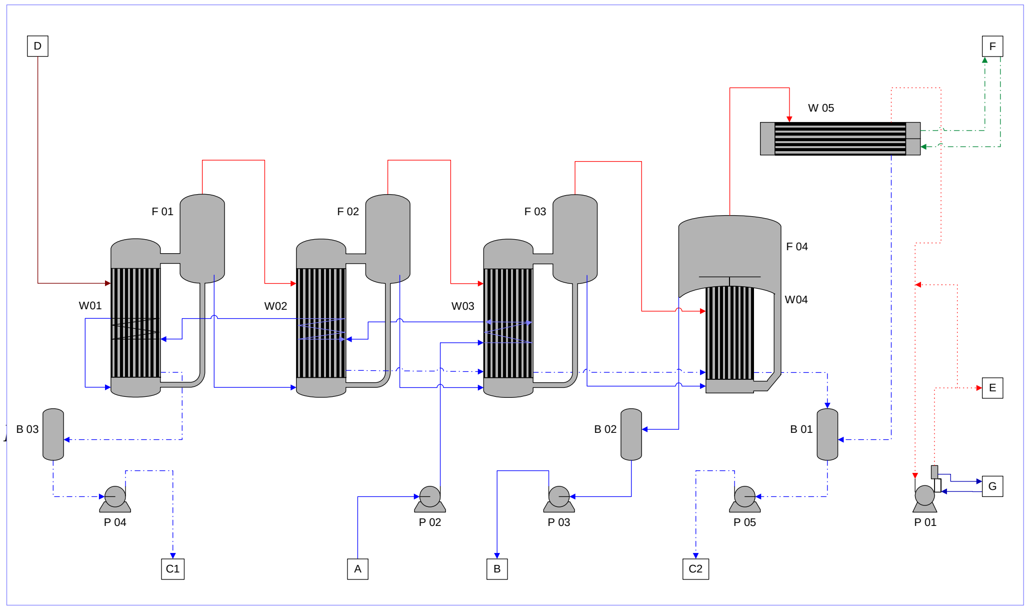


Fig. 6:
Natural circulation evaporator with divided boiling chamber (mushroom evaporator)



4-effect circulation evaporator, directly heated with live steam

A	*Glycerine water feed*	*B*	*Glycerine water discharge*	*C1*	*Live steam condensate*
C2	*Vapour condensate*	*D*	*Live steam*	*E*	*Ventilation*
F	*Cooling water*	*G*	*Service water*		

Fig. 8:
4-effect falling-film / natural circulation evaporator
6205 kg/water evaporation
for saponification glycerine
Feed 7000 kg/h, 10 % glycerine
Discharge 795 kg/h, 88 % glycerine

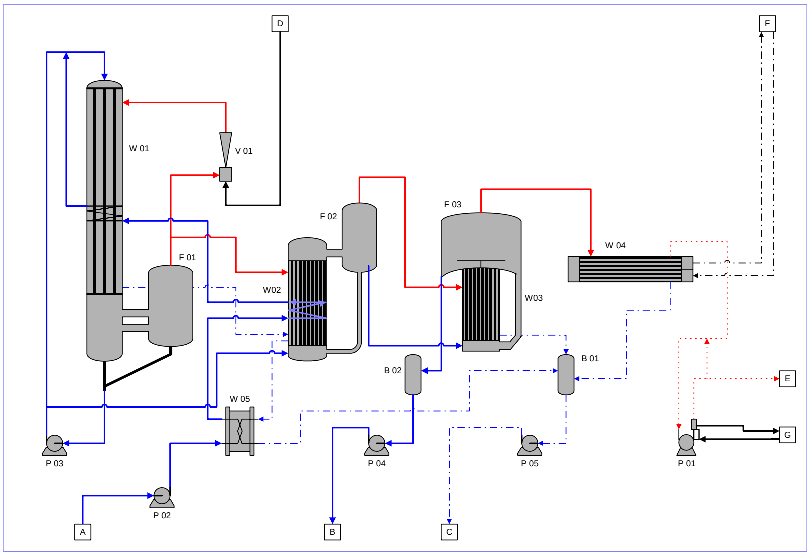


Fig. 9: 3-effect falling-film natural circulation evaporator, heated by thermal vapour recompressor

A Glycerine water feed
B Glycerine water discharge
C Vapour condensate
D Live steam
E Ventilation
F Cooling water
G Service water

For higher evaporation rates and for the use of a thermal or mechanical vapour recompressor in order to save energy the falling film evaporator (fig. 6) offers important advantages.

Contrary to the circulation evaporator which requires a min. temperature difference of 6-10 °C for a stable operation, the falling film evaporator can be designed with any small temperature difference. In this way, a higher number of effects can be used and the steam consumption can be reduced when using a vapour recompressor.

The use of a falling film evaporator as high concentrator with very low boiling pressure allows to achieve final concentrations of up to 99.8 %.

When evaporating salt-containing spent lye glycerine sodium chloride will precipitate during the concentration if the saturation concentration is exceeded.

Within the range of these concentrations the evaporator therefore has to be designed as forced circulation evaporator (fig. 11) or as crystallizer.

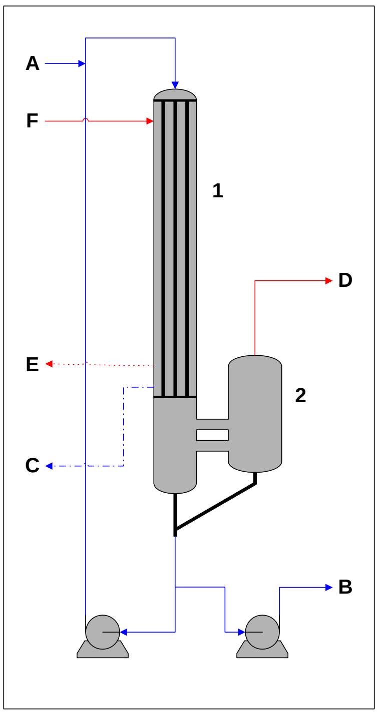


Fig.10: Falling-film evaporator

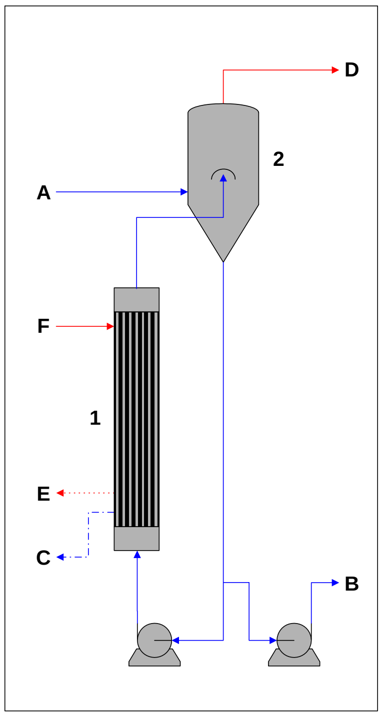


Fig. 11: Forced circulation evaporator/crystallizer

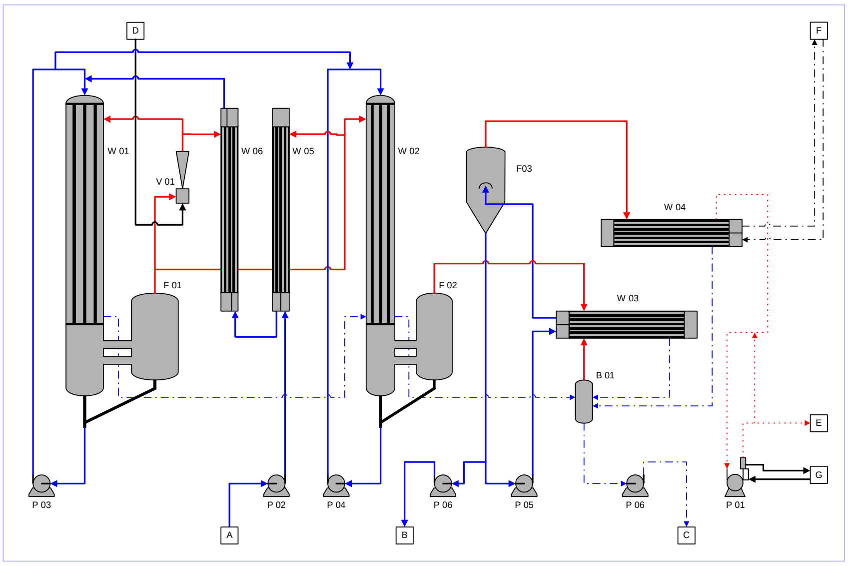


Fig. 12: 3-effect falling film/ forced circulation evaporator
4167 kg/h water evaporation for salt-containing spent lye glycerine
Feed 5000 kg/h, 15% glycerine
Discharge 833 kg/h, 90% glycerine

Fig. 13: 3-effect falling film forced circulation evaporator, heated by thermal vapour recompressor

A	*Glycerine water feed*	*B*	*Glycerine water discharge*
C	*Vapour condensate*	*D*	*Live steam*
E	*Ventilation*	*F*	*Cooling water*
G	*Service water*		

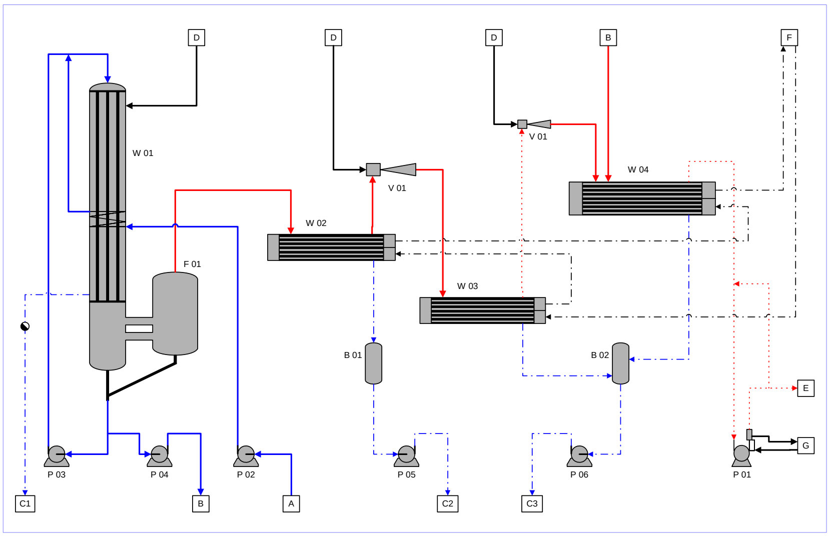


Fig. 14: 3-effect falling film evaporator
5515 kg/h water evaporation for saponification glycerine
Feed 6000 kg/h, 8% glycerine
Discharge 485 kg/h, 99 % glycerine

Fig. 15: 1-effect falling film high concentrator, directly heated with live steam

A	*Glycerine water feed (>90%)*	*B*	*Vapour from the pre-evaporator*
C1	*Live steam condensate*	*C2*	*Glycerine condensate*
C3	*Vapour condensate*	*D*	*Live steam*
E	*Ventilation*	*F*	*Cooling water*
G	*Service water*	*K*	*Glycerine water discharge (>99.5%)*

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GEA Group is a global engineering company with multi-billion euro sales and operations in more than 50 countries. Founded in 1881, the company is one of the largest providers of innovative equipment and process technology. GEA Group is listed in the STOXX® Europe 600 Index.

GEA Process Engineering

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