Evaporators for Stillage Concentration

GEA Wiegand GmbH

Evaporation for Stillage Concentration

The spent residues that result as by-products from sugar and starch processes, yeast production, fermentation processes and alcohol distilleries are generally called spent wash, vinasses or stillage.

Depending on the raw materials being processed, the following stillages exist:

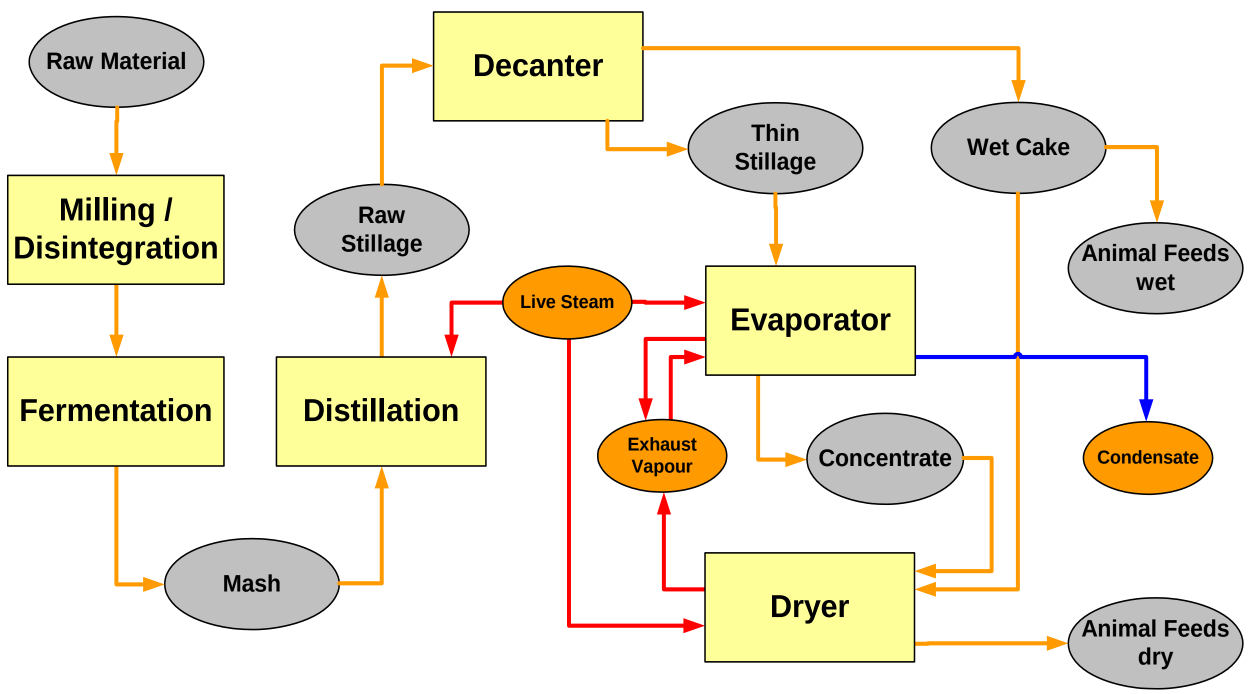
- Molasses (vinasses)
- Grain stillage:
  wheat, rye, maize, triticale, sorghum stillage
- Potato stillage
- Whisky stillage (barley, pot ale)
- Yeast stillage

These thin liquor stillages contain all the nutrients of the raw materials except for their fermented starch and sugars: i.e. they contain proteins, fat, fibre, minerals etc. in greater concentrations than were present in the original raw material. These liquors can therefore be processed into added-value animal feeds by concentration and, if necessary, drying and crystallisation/precipitation of certain seals (e.g. potassium, sodium).

GEA Wiegand has a global reputation as a specialist engineering company, with a reputation that goes back nearly 100 years.

Furthermore, GEA Wiegand has extensive expertise in the range of upstream and downstream processes and unit operations required in the field of stillage concentration.

Fig. 1: Diagram of an alcohol plant with a thermally integrated stillage concentration system



Concentration and temperature

The thin stillages resulting from alcohol distilleries typically have a concentration range of between 5 and 10 % TS.

The final concentration that can be achieved depends on the type of raw material being processed, the qualities achieved by mechanical separation (the amount of suspended versus dissolved solids), and the fermentation process (table). Viscosity of the concentrated liquor is normally the measure that determines the upper concentration limit.

The concentrate quality, dried stillage quality and fouling behaviour are largely influenced by the temperatures within the evaporator. Temperatures of between 50° and 105 °C are used. .

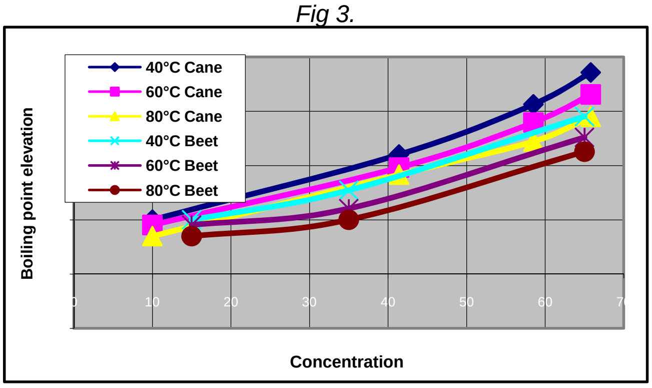
Properties of Feed liquors and Concentrate following evaporation

	Raw Material Type of Stillage	Sugar Beet Sugar Cane	Barley (Whisky)	Wheat Rye	Maize	Yeast
Thin Stillage Feed	**% TS**	7 -10	5 -6	7 -9	5 -7	5 -10
	Viscosity cP	<1	<1	<1	<1	<1
	Density kg/m³	1030	1020	1030	1020	1030
	Temperature °C	60 - 100	70 - 90	60 - 80	50 - 70	30 - 50
Stillage Concentrate Discharge	**% TS**	50 - 65	40 - 45	25 - 30	30 - 50	50 - 65
	Viscosity cP	20 - 150	300 -800	500 - 1000	200 - 500	100 - 150
	Density kg/m³	1300 - 1400	1100	1060	1060 - 1150	1200 -1300
	Temperature °C	50 - 60	70 -105	60 - 80	60 - 80	60 - 70
	ßs °K	5 - 8	2 - 4	1 - 2	2 - 4	8 - 15

Fig. 2:Stillage viscosity versus concentration.

Fig 3:Boiling point elevation (in degrees Celsius) versus concentration.

Fig 3.



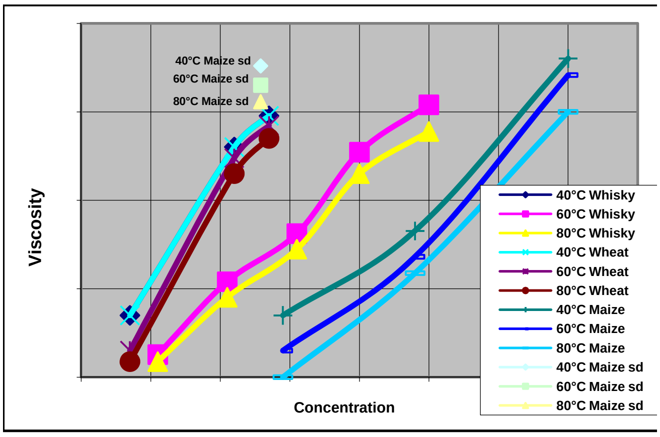


Fig. 2

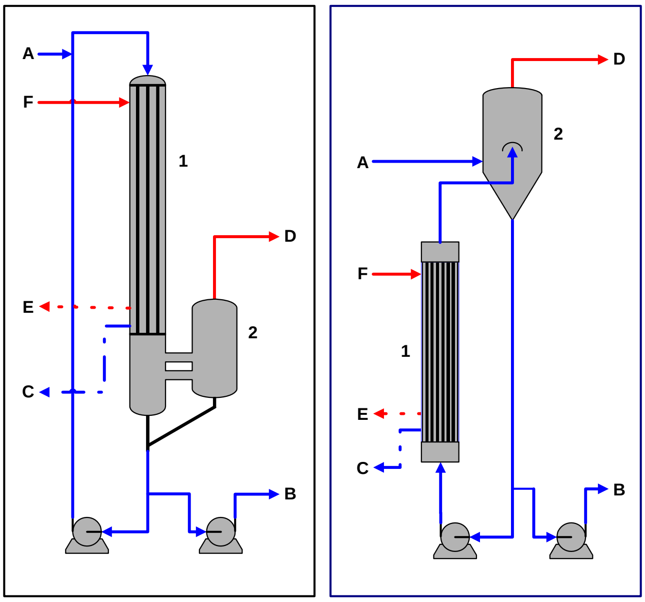
The properties of stillage from the same raw material can differ significantly due to seasonal variations, and are affected by the method of pretreatment. Specialized analysis and evaporation tests are therefore required to verify the design conditions in each individual case.

GEA Wiegand has its own established Research and Development Centre, where state-of-the-art laboratory equipment, fixed and mobile pilot plants are available for evaporation trials, testwork and specialized analysis.

Evaporator selection

Falling film and forced circulation evaporators are used for the concentration of stillage. Evaporator selection is normally determined by the required concentration ratio, the evaporation rate, the type of heating or heat recovery system, and in particular, by the viscosity and fouling characteristics of the stillage. Falling film evaporators are used for low viscosities, of up to about 100 cP and large evaporation rates. For higher concentration ranges, forced circulation evaporators are used, handling viscosities of up to 1000 cP, for example.

Where the product has a tendency to scale or foul, e.g. in the case of a vinasses containing calcium sulphates, for forced circulation evaporators are commonly used.



A *Product* ***D*** *Vapour* ***1*** *Falling film calandria*
B *Concentrate* ***E*** *Deaeration* ***2*** *Forced circulation calandria*
C *Condensate* ***F*** *Steam* ***3*** *Separator*

Plant arrangements

The arrangement of an evaporator is determined by the type and quantity of the liquor to be processed, the energy available and the operating period required for the plant. In most cases, the plant arrangement depicted in one of the following examples is selected:

Fig. 4: 5-effect falling film and forced circulation evaporator, heated by thermal vapour recompressor, concentrating 30 tonnes/hr vinasses, arrangement A

Arrangement A:

Multiple-effect, combined falling film and forced circulation evaporator, heated with live steam or by thermal vapour recompressor

Arrangement B:

Falling film pre-evaporator heated by mechanical vapour recompressor (MVR) and forced circulation finisher, heated by steam or mechanical vapour recompressor, for medium to large evaporation capacities, 20 to 120 tonnes/hr.

Arrangement C:

Combined falling film and forced circulation evaporator, heated by dryer exhaust vapour, for medium to very large evaporation capacities, 50 to 150 tonnes/hr

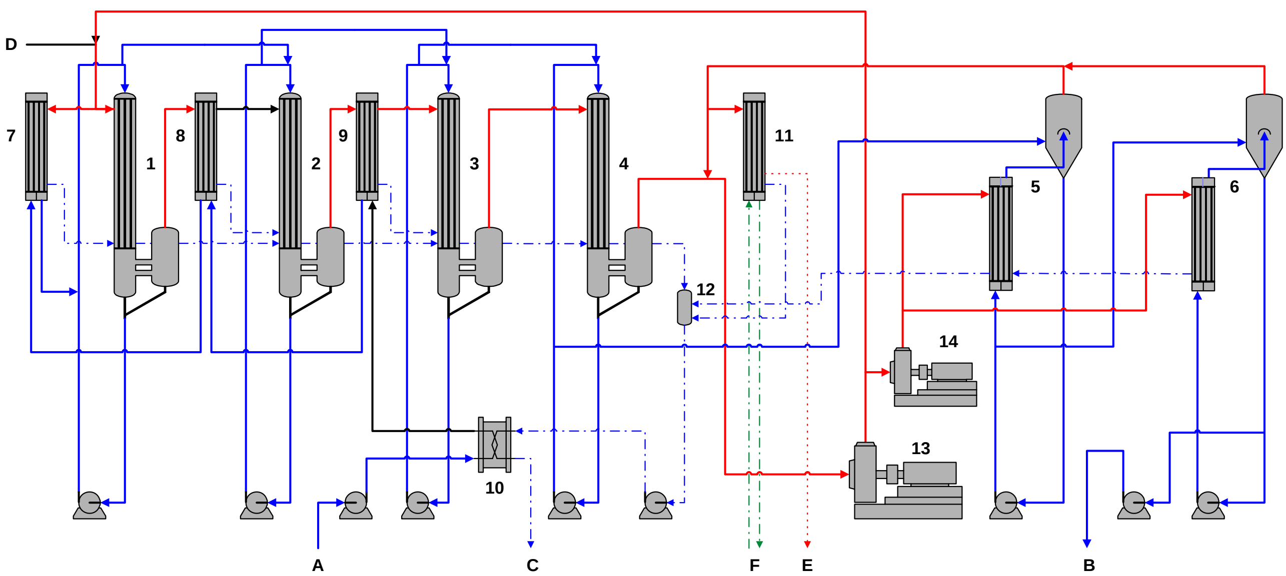
Arrangement D:

Combination of two or more lines of typ B arrangement, for the treatment of extremely large stillage quantities exceeding 150 tonnes/hr evaporation

Fig. 5:
4-effect falling film and forced circulation evaporator, heated by mechanical vapour recompressor, concentrating 125 tonnes/hr of whisky stillage, as per arrangement B
(flow sheet in fig. 6)

Fig.. 6

1 – 4	*Falling film effects*	*10*	*Plate preheater*	*A*	*Product*	*D*	*Live steam:*
5, 6	*Forced circulation effects*	*11*	*Condenser*	*B*	*Concentrate*	*E*	*Deaeration*
7 - 9	*Straight tube preheater*	*12*	*Condensate vessel*	*C*	*Condensate*	*F*	*Cooling water*
		13, 14	*Mechanical vapour recompressors*				



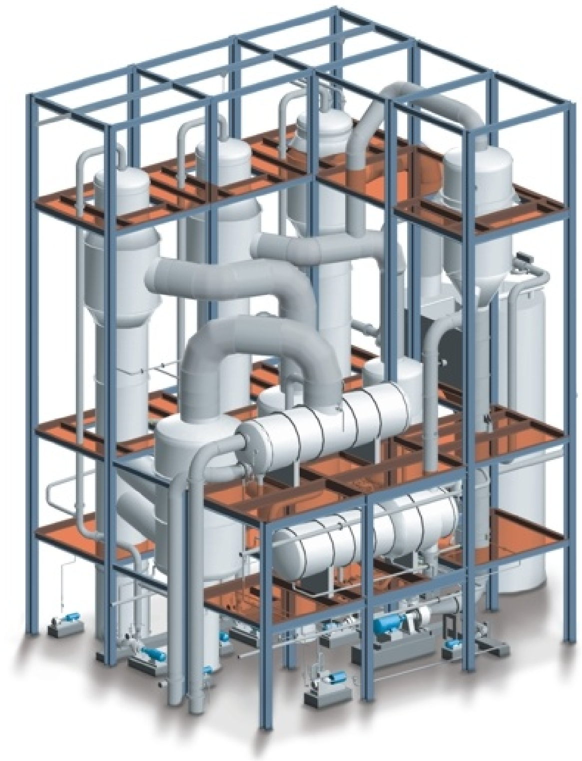
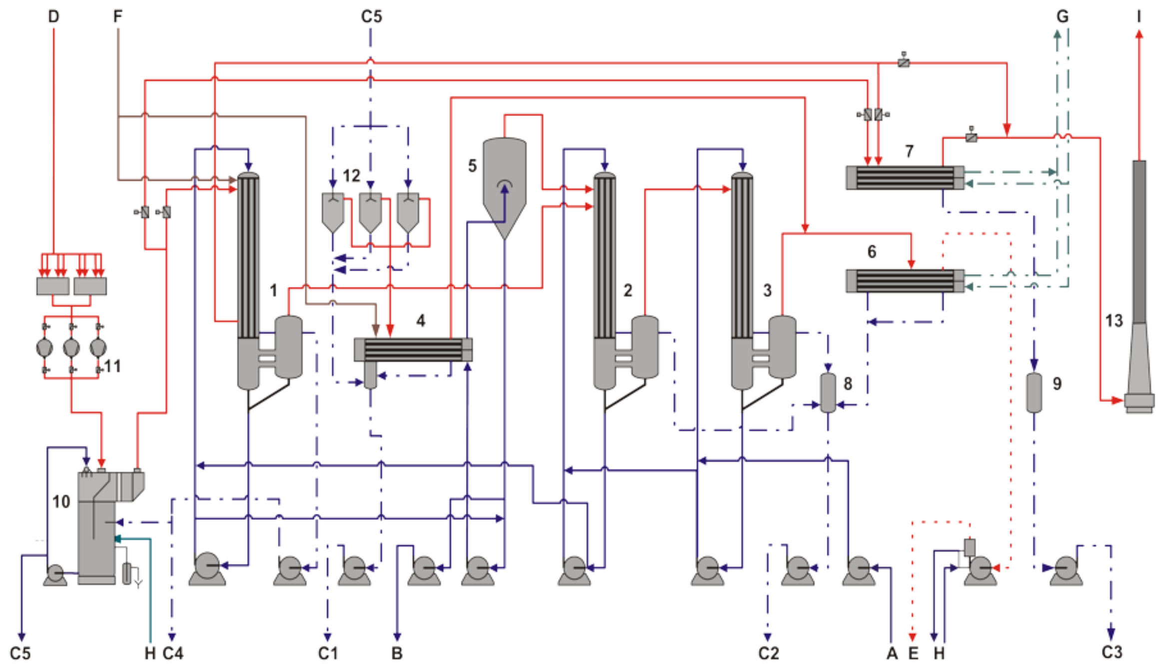


Fig. 7: 5-effect falling film and forced circulation evaporator, heated by dryer exhaust vapour, concentrating 140 tonnes/hr of stillage from 6.6 % to 35 % TS, arrangement C

Fig.. 8:

1 – 3	*Falling film effects*	*10*	*Vapour scrubber*	*A, B*	*Product, concentrate*	*E*	*Deaeration*
4	*Forcedc circulation effect*	*11*	*Vapour fans*	*C1, C6*	*Cleaned condensate*	*F*	*Live steam*
5	*Separator*	*12*	*Condensate flash vessel*	*C2 – 4*	*Vapour condensate*	*G*	*Cooling water*
6, 7	*Condensers*	*13*	*Exhaust stack*	*C5*	*Foul condensate*	*H*	*Service water*
8, 9	*Condensate feed tanks*			*D*	*Dryer exhaust vapour*	*I*	*Exhaust air and vapour mixture*



Animals feeds plant

The following diagram depicts the most common process for the processing of wheat stillage, the DDGS (dried distiller's grains with solubles) animal feeds plant.

The raw stillage is first transferred through a high-performance centrifuge, where the wet cake containing about 30 % TS is decanted.

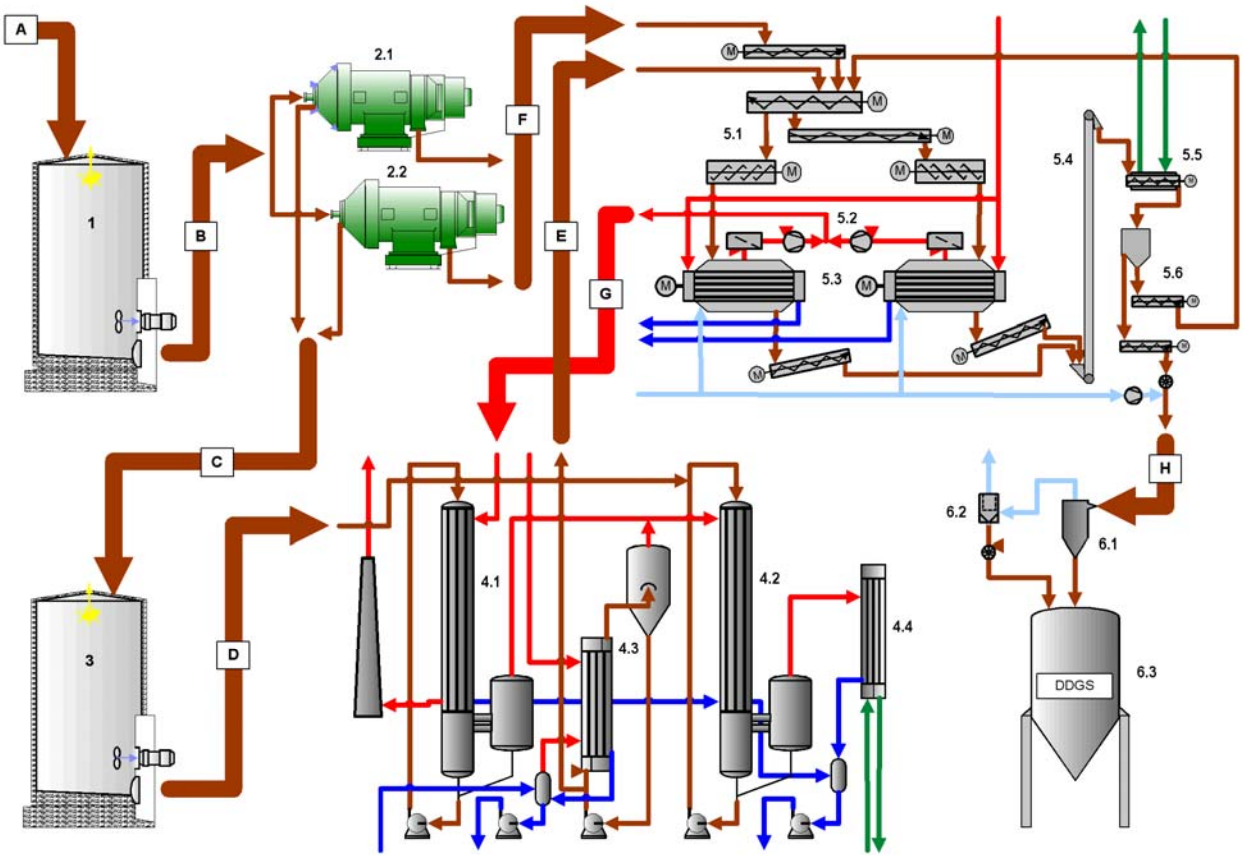
The remaining thin stillage, from which suspended solids have been separated to the largest possible extent, is conveyed through buffer tanks to the evaporation plant, where it is concentrated to about 28 – 42 % Ts.

The stillage concentrate from the evaporator and the wet cake from the decanter are transferred to the drying system, where they are mixed with recycled dry material and finally dried to a residual moisture of about 5 – 10 %.

Ring dryers or steam tube dryers are generally used for the drying of DDGS.

Fig.. 9:

A, B	*Raw stillage*	*1*	*Raw stillage tank*
C, D	*Thin stillage*	*2*	*Decanter*
E	*Concentrate*	*3*	*Thin stillage tank*
F	*Wet cake*	*4*	*Evaporation plant*
G	*Dryer vapours*	*5*	*DDGS dryer*
H	*Dried stillage/DDGS*	*6*	*DDGS-silo*



Overview on our Range of Products

Evaporation plants
to concentrate any type of fluid products and waste water deriving from food, chemical and pharmaceutical industries; with additional equipment for heating, cooling, degassing, crystallization, rectification.

Membrane filtration – GEA Filtration
to concentrate fluid food, process water, organic and inorganic solutions and waste water, to separate contaminations in order to improve quality and recover valuable substances.

Distillation / rectification plants
to separate multi-component mixtures, to recover organic solvents; to clean, recover and dehydrate bio-alcohol of different qualities.

Alcohol production lines
for industrial, neutral, extra neutral and drinking alcohol; integrated stillage processing systems

Condensation plants
with surface or mixing condensers, to condense vapour and steam/gas mixtures under vacuum

Vacuum/steam jet cooling plants
to produce cold water, cool liquids, even of aggressive and abrasive nature.

Jet pumps
to convey and mix gases, liquids, and granular solids; for direct heating of liquids; as heat pumps; and in special design for the most diverse fields of application.

Steam jet vacuum pumps
suction pressure up to 0.01 mbar; product vapour driven; also in combination with mechanical vacuum pumps; extensive application in the chemical, pharmaceutical and food industries; also in oil refineries and for steel degassing.

Heat recovery plants
to utilize residual heat from exhaust gases, steam/air mixtures, condensate and product.

Vacuum degassing plants
to remove dissolved gases from water and other liquids.

Heating and cooling plants
mobile and stationary plants for the operation of hot water heated reactors, contact driers.

Gas scubbers
to clean and dedust exhaust air, to separate aerosols, to cool and condition gases, to absorb gaseous pollutants.

Project studies, engineering for our plants

GEA Process Engineering

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