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Effect of different parameters on economy of single effect evaporator.

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Abstract- ***The term economy with reference to evaporator used to express the amount of steam required to vaporize the solvent per hour. The present study considered the change in different parameter like feed temperature, steam pressure in order to observe their direct effect on evaporator economy. Thermal condition of the evaporator feed has a significant impact on economy and performance. Though steam pressure also affects evaporator economy. The paper considered all results concluded after changing the parameters including graphical presentation.***

Keywords- *Economy, Evaporator, capacity, temperature, pressure.*

I. INTRODUCTION

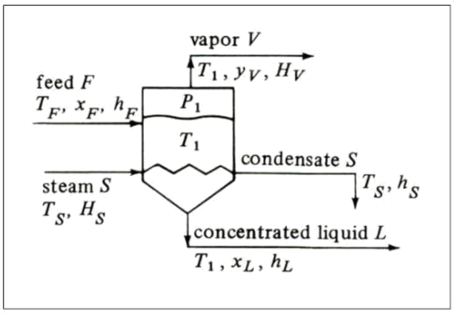
Evaporation ordinarily means vaporization of a liquid or that of a solvent from a solution. In chemical engineering terminology, “evaporation means removal of a part of the solvent from a solution of a nonvolatile solute by vaporization.” The weak liquor is generally composed of a nonvolatile solute & volatile solvent. Evaporation is conducted by vaporizing a portion of the solvent to produce a concentrated solution of thick liquor. The common heating medium is generally a low pressure steam but in some situations other sources that might be used are: solar energy, fuel, electricity, hot oil & flue gas.

Evaporation differs from the other mass transfer operations such as distillation and drying. In distillation, the components of a solution are separated depending upon their distribution between vapor and liquid phases based on the difference of relative volatility of the substances. Removal of moisture from a substance in presence of a hot gas stream to carry away the moisture leaving a solid residue as the product is generally called drying. Evaporation differs from crystallization in that emphasis is placed on concentrating a solution rather than forming and building crystals.

Normally, in evaporation the thick liquor is the valuable product, & the vapor is condensed & discarded. But in one specific situation, mineral-bearing water often is evaporated to give a solid–free product for boiler feed, for special process requirement, or for human consumption. This technique is often called water distillation. Large –scale evaporation processes have been developed and used for recovering potable water from seawater. Here the condensed water is the desired product. Evaporation is a heat transfer operation in which the solvent is boiled off and vaporized from the solution to which the heat energy is supplied by the condensing steam on the shell side of a shell and tube type steam chest.

Evaporation is an operation used to concentrate a solution containing non-volatile solute and a solvent. Difference between evaporation and crystallization is that in evaporation, vaporizing solvent is the main function while in crystallization crystalline product and crystal growth is main function. Evaporation is common in chemical process industries such as, food, pulp and paper, pharmaceutical, fine chemicals, organic and inorganic chemicals, polymers etc. Design of evaporator depends upon characteristics of solute and solvent. The solute can be heat sensitive, can have tendency to polymerize or agglomerate on heat transfer surface. Solvent can be viscous liquid or an emulsion which can break down. All these parameters have to be considered while selecting and designing an evaporator.

The solution containing the desired product is fed into the evaporator and passes a heat source. The applied heat converts the water in the solution into vapor. The vapor is removed from the rest of the solution and is condensed while the now concentrated solution is either fed into a second evaporator or is removed. The evaporator as a machine generally consists of four sections. The heating section contains the heating medium, which can vary. Steam is fed into this section. The most common medium consists of parallel tubes but others have plates or coils. The concentrating and separating section removes the vapor being produced from the solution. The condenser condenses the separated vapor, then the vacuum or pump provides pressure to increase circulation.



EXPERIMENTAL WORK AND CALCULATION:

Experimental work considered the study of salt-water system for which economy to be calculated.

In the figure vertical tube evaporator shown which stated at our Laboratory

Parameter 1: Feed temperature

Evaporation time = 3 hours

Steam pressure = 2.5 Kg/cm^2

Feed flow rate = 7.5 LPH

Feed initially taken = 10 litre

For economy calculation:

Flow rate of vapour generated (capacity) = M

Flow rate of steam used:

= M_S

$$= \frac{\text{condensate collected (lit)}}{\text{Time (hr)}}$$

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Economy:

$$= \frac{M}{M_S} = \frac{\text{Flow rate of vapor generated (capacity)}}{\text{Flow rate of steam used}}$$

Temperature (^{0}c)	Flow rate (LPH)		Economy
	M	Ms	
25	1.4	1.792	0.7812
30	1.412	1.773	0.7962
35	1.432	1.762	0.8126
40	1.446	1.755	0.8236
45	1.462	1.727	0.8462
50	1.476	1.723	0.8563

Parameter 2: steam pressure

Evaporation time = 3 hours

Feed temperature = 25 ^{0}c

Feed flow rate = 7.5 LPH

Feed initially taken = 10 litre

For economy calculation:

Flow rate of vapour generated (capacity) = M

$$= \frac{\text{condensed vapor collected (lit)}}{\text{Time (hr)}}$$

Flow rate of steam used:

$$= M_S = \frac{\text{condensate collected (lit)}}{\text{Time (hr)}}$$

Economy:

$$= \frac{M}{M_S} = \frac{\text{Flow rate of vapor generated (capacity)}}{\text{Flow rate of steam used}}$$

Steam pressure Kg/cm^2	Flow rate (LPH)		Economy
	M	M_S	
1.5	1.05	1.863	0.5683
2.5	1.1	1.765	0.6265
3.5	1.15	1.693	0.6795
4.5	1.07	1.556	0.6932
5	1.06	1.492	0.7136

EFFECTS OF PARAMETERS ON ECONOMY:

1. Feed temperature:

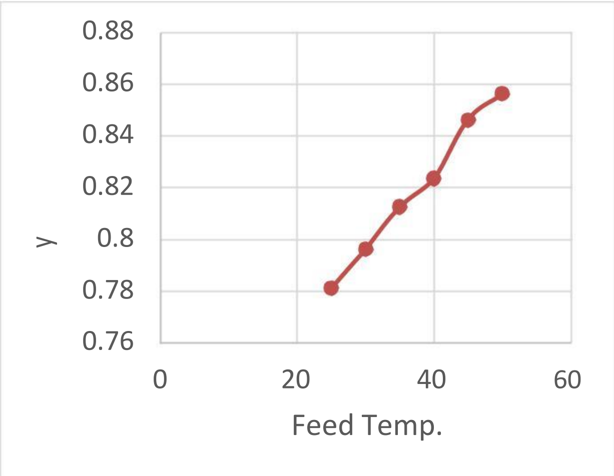

Fig. shows the effect of feed temperature on economy.

From the plot we can see that economy increases almost linearly with feed temperature. If we increases feed temperature that means we are supplying sensible heat to the feed and it is beneficial for improving economy because sensible heat is more economical than the latent heat.

2. Steam pressure:

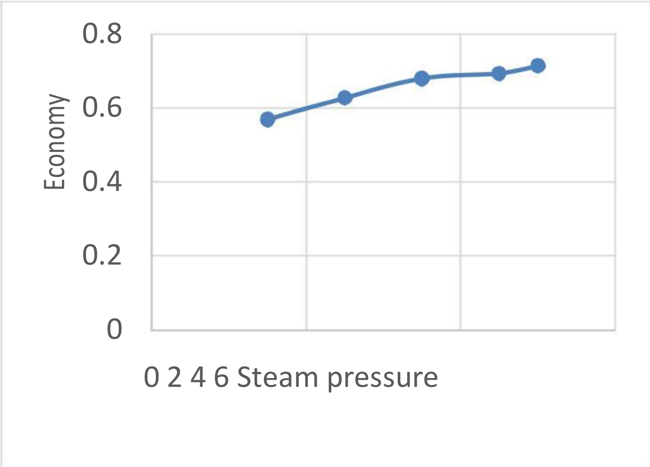

Fig. shows the effect of steam pressure on economy.

Economy of single effect evaporator increases with increase in steam pressure because as we increase steam pressure, temperature of steam or latent heat of steam increases and thus we require less steam for the evaporation.

Conclusion:

In the present study, single effect evaporator was studied. As different experiments was performed for single effect evaporator with changing various parameter and seen effect of same on economy.

We found that economy of evaporator increases as we increase feed temperature and steam pressure.

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