Improving energy efficiency of the evaporator unit

Example applications

- Milk powder
- Whey product
- Sugars
- Salts
- Juices
- Instant coffee
- Food powder
- Solvent recovery
- Titanium sulphate
- Fertilisers
- Pulp manufacturing

Process description

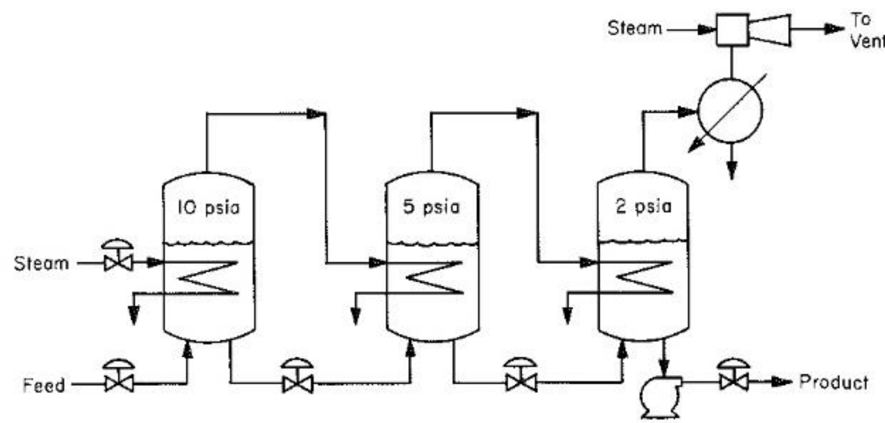
- The process involves heating the solution to be evaporated by passing it through a series of evaporating columns.
- To control final product concentration the operator manipulates the temperature in the evaporator columns.
- As the operator does not have a direct handle on temperature, the operator must rely on secondary adjustments such as evaporator steam or feed flow rate.
- The process requires constant attention as process disturbances to the evaporator, such as changes in feed density or steam pressure, can cause the product concentration to deviate from target.

Energy savings opportunity

Since the evaporator products contain no more energy than the feed, all of the heat that is applied to separate them is ultimately lost to the environment. Consequently the more efficiently the process is operated, the greater the energy savings achieved.

How Spiro improves energy efficiency

- Precise control of product quality
- Running closer to specification: reduces product giveaway and improved downstream unit performance
- Reduced risk of fouling
- Improved start-up control
- Optimisation of plant steam network



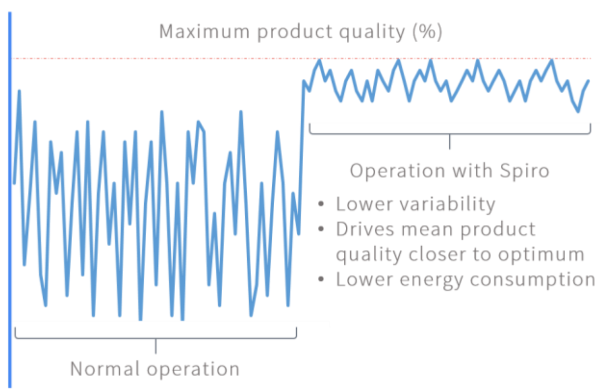
SIMPLE THREE-EFFECT EVAPORATOR

Energy savings and reduced CO_2 footprint through tighter controls

Precise control of product quality is an integral part of any energy conservation program. Products must meet certain specifications, and failure to meet these specifications generally entails some penalty such as reprocessing or blending with higher quality material. All these choices are wasteful of energy.

To avoid these penalties most operators attempt to control with a very safe margin. This gives away more valuable product and uses more energy to achieve the higher concentration. Other penalties may also arise such as product degradation and fouling of heat transfer surfaces caused by over-concentration.

By using a model of the process, together with sensor data, our solution significantly reduces variability in the process. As a result, the unit can run much closer to specification and so optimise the amount of energy used.



A further way in which our solution facilitates tighter control of the process to reduce energy spend is by providing a continuous estimate of product concentration. The continuous measurement estimate is calculated using the model of the process, periodic laboratory samples and secondary measurements such as temperature, pressure and flowrate. This feature of the device effectively acts like an online analyser and facilitates tight control of product concentration without you having to invest in expensive new equipment.

A full return on investment can typically be achieved from the energy savings alone within **6 months**

Plant-wide energy optimisation

The ability of evaporators to operate on low pressure steam makes them very economical and central to the plant steam network. By integrating operation of the evaporator into a plant-wide steam management system, you can reduce steam venting, reduce let-down and reduce fuel consumption in the steam generators; resulting in significant savings.

Example application: Milk powder

In a milk powder production line, evaporators are used to remove excess water before the concentrate enters a spray dryer. Optimisation of this unit is critical as it impacts dryer performance. An increase in the mean solids level from the evaporators can lead to a significant increase in spray dryer throughput.

Typical benefits achieved from optimised control:

- >50% reduction in total solids variability
- 5% specific steam savings
- 5-10% increase in throughput

Example application: Sugar

An evaporator is used to raise the concentration of sugar cane juice so that it becomes a syrup. The evaporation process is one of the most energy consuming units in sugar production. Tighter regulations, increased energy costs and increased competition all combine to enhance the need for better control of this unit.

Typical benefits achieved from optimised control:

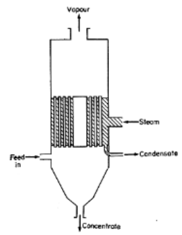
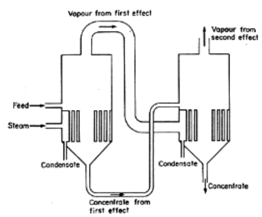
- >50% reduction in Brix variability
- 2% energy savings due to reduced steam requirement
- ~3% increase in sugar production

Example application: Pulp & paper

In the pulp and paper industry, multi-effect evaporators are used to evaporate water from black liquor solutions. The energy intensive nature of the evaporation process creates significant opportunities to increase profitability by optimising the control of this unit.

Typical benefits achieved from optimised control:

- >50% reduction in liquor solids variability
- ~2% increase in thermal efficiency
- Significant increase in run time due to reduced fouling

EVAPORATOR	PROCESS ARRANGEMENT	OPERATIONAL BENEFITS DELIVERED BY SPIRO	ECONOMIC BENEFITS DELIVERED BY SPIRO
NUMBER OF EFFECTS	 Single-effect	Variability in energy consumption and product concentration is reduced through accurate control of the following variables: • Vapour rate • Temperature/pressure profile • Temperature and viscosity of concentrate • Concentrate re-circulation • Vapour condenser • Product level	• Increased throughput • Reduced process waste • Steam savings or increase product yield at same energy spend. When operation of the evaporator is integrated into a plant-wide steam management system, significant savings can be achieved through reduced steam venting, reduced let-down and reduced fuel consumption in the steam generators.
	 Multi-effect	Thermally insensitive products may use many effects (>10), heat losses make each added effect slightly less efficient making each increment of capital investment less attractive. Products that are temperature sensitive such as food products are limited to evaporation in 2 or 3 effects. The temperature of the last effect is limited by cooling capacity and product viscosity (co-current flow) whereas the temperature of the first effect is limited by the thermal sensitivity of the product. Spiro can manage these operating constraints to maximise efficiency without product degradation.	• Increased throughput • Reduced process waste • Steam savings or increase product yield at same energy spend The challenge in operating a multi-effect evaporator is that disturbances in the feed or steam supply will have a knock-on effect throughout the process. Additional effects also introduce more process lag making control more complex. Spiro can model this process lag and provide significantly improved response to process disturbances resulting in significantly reduced product variability.
VAPOUR RECOMPRESSION	Thermal vapour recompression	Motive steam is used to compress part of the vapour from a low pressure up to first effect conditions. The first effect heat energy is re-used making this system more cost effective and efficient than adding additional effects. Spiro can manage the vapour recompression by adjusting thermal load in response to throughput changes.	Additional energy savings are achieved through optimising the thermal efficiency of vapour recompression by adjusting suction pressure and minimising compressor recycle or by-pass.
	Mechanical vapour recompression	In mechanical vapour recompression, electric energy is used indirectly to heat the plant instead of live steam. Spiro can manage the vapour recompression by adjusting thermal load in response to throughput changes and can manage compressor operation for maximum efficiency.	Maximum operating efficiency is achieved by managing compressor speed, suction pressure and vapour by-pass.