Haffmans

Thinking outside of the box reduces operational costs

Three new ways to reduce operational costs by using CO_2 recovery

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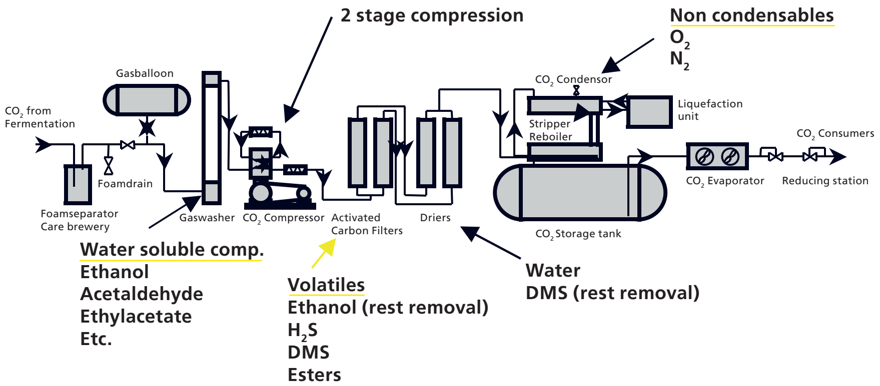
Breweries are seeing an increasing amount of pressure placed on prices and have to take a critical look at their costs. This is difficult, because marketing costs are increasing, it appears to be almost impossible to reduce the process costs and environmental regulations are becoming increasingly stricter. However, the end user wishes to enjoy an excellent beer for a reasonable price and, for this reason, breweries must find clever cost savings.
Haffmans has developed three concepts for reducing costs via the use of CO_2 recovery technology. This not only concerns reducing costs by producing CO_2 at a cheap price. Haffmans looked further than just the CO_2 recovery process and by thinking outside of the box, a number of interesting possibilities were exposed.



Haffmans CO_2 Recovery Plant

CO2 recovery

Before discussing these possibilities, it will first be explained how the CO_2 is recovered.
CO_2 is produced during fermentation. Any foam residue is removed in a foam separator and the CO_2 gas is then collected and stockpiled in a gas balloon. The gas is passed through a gas washer in which water soluble components, such as ethanol, are removed by passing it in counter-current through water. The gas is then compressed to 17 bar and passed through a bed of active carbon and a drying agent. The active carbon removes unwanted smells, such as H_2S and DMS, from the CO_2 and the drying agent removes moisture from the gas. Once the CO_2 has been dried, the gas can be cooled in a condensor without the risk of freezing. CO_2 liquefies at low temperatures, whilst other gases (CO_2 and N_2) will not liquefy during condensation. As a result of the extraction of the non-condensable O_2 and N_2 gases, this step has a substantial effect on the purity of the CO_2. The liquefied CO_2 is stored in a storage tank, vaporized again and finally supplied, at the desired pressure, to the brewery processes which require CO_2, such as water degassing and carbonization.

Process links

CO_2 washing requires a great deal of energy. The most energy is consumed when the gas is compressed, when removing the smells and drying the gas, and during liquefaction and vaporization of the CO_2.
There are a number of reversible processes in the recovery process. CO_2 is first liquefied, whilst in the next step, it is vaporized. This means that a great deal of energy must first be extracted, whilst later, almost the same amount of energy is added again. Another example is the compression of the gas. Before the gas is sent to the brewery, the pressure must be slightly reduced.
By linking such processes to other processes, both inside and outside of the recovery process, the costs can be considerably reduced.
In this article, three systems for recovering energy during the vaporization of CO_2, which have been developed by Haffmans, are presented.

- Haffmans Heat Recovery System-Direct
- Haffmans Heat Recovery System-Indirect
- Haffmans Heat Recovery System-LiquiVap

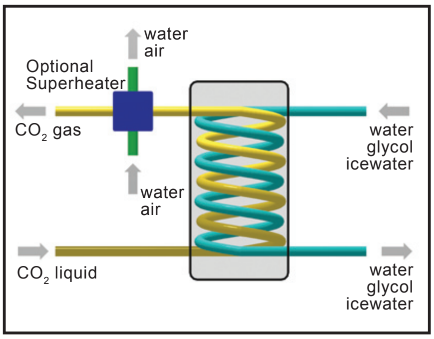
Haffmans Heat Recovery System-Direct

There are a number of processes within the brewery where energy is released. These processes (such as fermentation or the cooling of compressors) must have a cooling unit. Most breweries install a cooling unit and sometimes an intermediate medium (glycol) is used for cooling. Cooling towers with open or closed water circulation systems are also sometimes used for cooling compressors.

On the other hand, there are also processes which require energy, such as the vaporization of .

Operational costs can be reduced by linking the processes which release energy to the processes which require energy. For a very small cooling unit or cooling tower, such a link will take the pressure off the cooling process, so that no further expansion of the cooling unit or cooling tower is necessary.

The solution which Haffmans offers is a direct Heat Recovery System. Glycol which has been heated in a fermentation tank is passed to a heat exchanger. Cold CO_2 is passed to the other side of the heat exchanger and, as a result, CO_2 will be vaporized and (hot) return glycol will be cooled. Possible agents which a brewery can use for this are glycol, iced water or cooling water. If glycol or iced water is used, the vaporized CO_2 must receive additional heating, however.



Heat Recovery System-Direct

Such a system quickly pays for itself. An example of a brewery where this system is used is given below. In this brewery, CO_2 is vaporized using steam. The costs have been reduced considerably by installing a direct Heat Recovery System. Furthermore, the glycol is cooled in advance, so that less pressure is placed on the glycol cooling system.

Annual production: 800,000 Hl/year
Costs for glycol: € 0.027/kW
Costs for steam: € 0.017/kg of steam

The investment in the Heat Recovery System paid for itself at this brewery within 19 months. In general, such systems pay for themselves within 12 to 24 months, although this depends on things such as the capacity of the HRS system, the costs for glycol and steam, and the number of hours that it is in operation.

Haffmans Heat Recovery System - Indirect

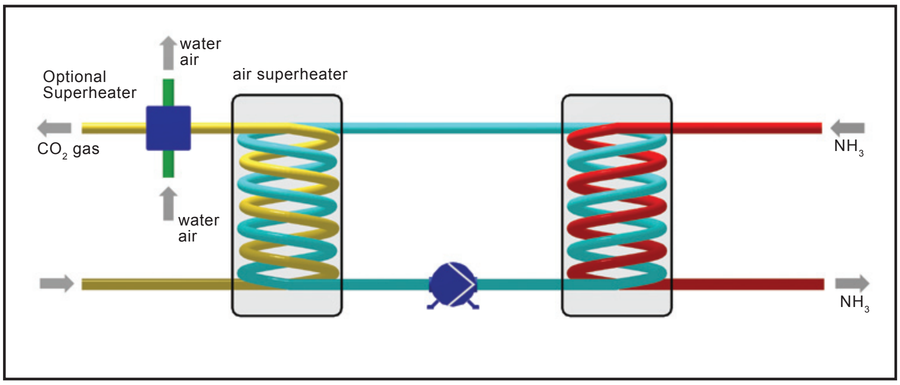
If breweries use NH_3 to cool processes, either directly or indirectly, this NH_3 can also be used as an energy source in a Heat Recovery System.

However, in the event of a leak, CO_2 and NH_3 would come into contact with each other (cross-contamination). There would be a chemical reaction between the gases and a salt would be formed. Such a reaction is extremely undesirable and would force the brewery to stop the entire production process.

In order to prevent cross-contamination, Haffmans has developed an indirect Heat Recovery System which uses an intermediate system. In the event of a leak, the second heat exchanger forms a physical barrier between the CO_2 and the NH_3. In view of the low temperature of the NH_3, additional heating is required though.

Haffmans has also tested this system in practice. The large advantage that cross-contamination is not possible requires a large investment though.

Consequently, it will generally take longer for such a system to pay for itself. It typically takes an indirect Heat Recovery System between 18 and 30 months to pay for itself, depending on things such as the capacity of the HRS system, the costs for glycol and steam, and the number of hours that it is in operation.

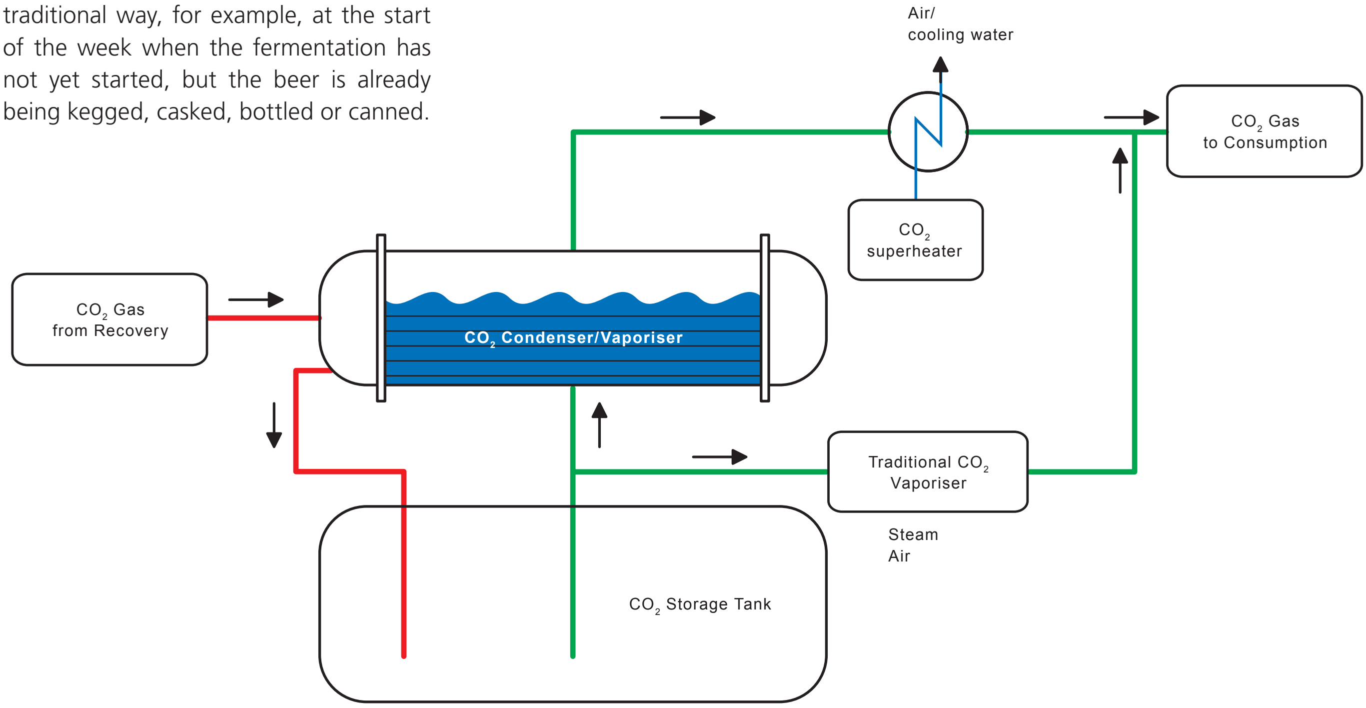


Heat Recovery System-Indirect

Haffmans Heat Recovery System - LiquiVap

For the third and last concept, Haffmans makes effective use of irreversible processes within the CO_2 recovery process. The large energy consumers within the process are linked to each other, so that, depending on the configuration, the net energy use for CO_2 recovery can be reduced by approximately 50%. A large quantity of energy must be extracted from the process during the liquefaction of CO_2. After it has been stored, a lot of energy is required again for vaporizing the CO_2. In the new Haffmans concept, both flows are brought together in the Heat Recovery System LiquiVap (Liquefaction-Evaporation). The HRS-LiquiVap system makes it possible to liquefy the CO_2 whilst using hardly any energy for cooling. If CO_2 production and consumption take place simultaneously, there is an immediate energy saving because the CO_2 extracted can then be used to liquefy the CO_2.

At the times when there is no CO_2 production or consumption, there is the possibility to liquefy or vaporize CO_2 in the traditional way, for example, at the start of the week when the fermentation has not yet started, but the beer is already being kegged, casked, bottled or canned.



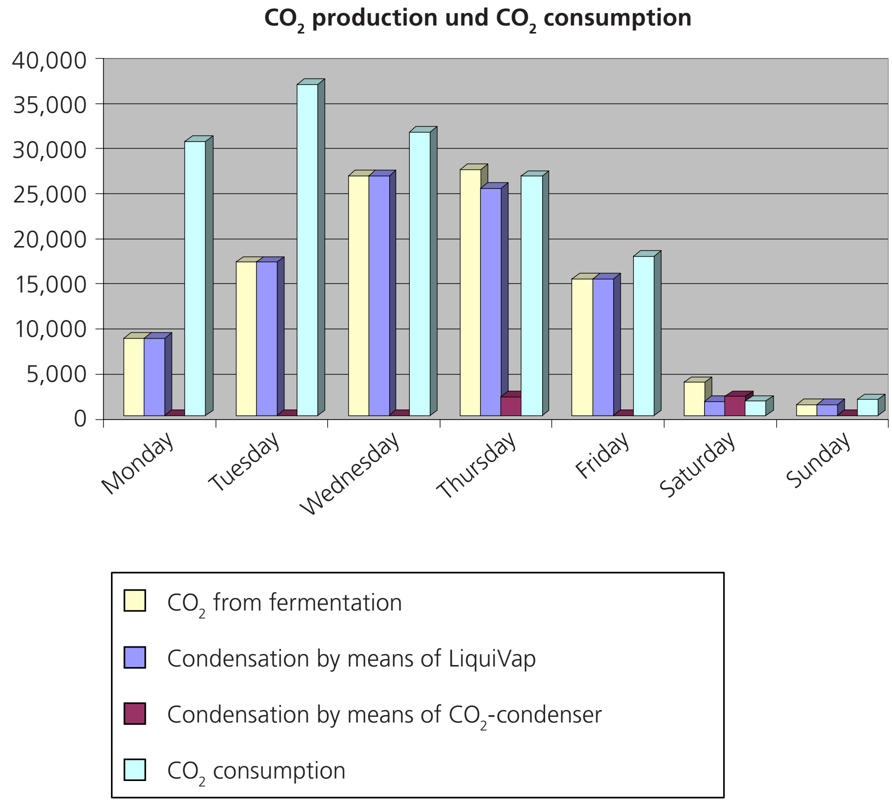
HMS-LiquiVap

This system has also been installed and undergone extensive testing at a brewery with an annual capacity of 2 million hectolitres. Besides a number of different beers, this brewery also produces a considerable quantity of soft drinks and other alcohol-free products. The results are very positive. The expectations at the beginning of the project have easily been exceeded. Since using the HRS-LiquiVap system, the brewery has saved energy for a number of processes, namely:

- CO_2 condensation energy with the consequent release of heat to the centralized brewery cooling system which is linked to this.
- Pre-cooling the cooling water.
- The energy necessary to vaporize CO_2 (steam).

The diagram below shows which part of the CO_2 is liquefied using the HRS-LiquiVap (blue bars). These bars indicate where the savings have been made. Condensation by means of the CO_2 condenser is indicated by the purple bars. The diagram below shows that the brewery concerned only needs to use the initially supplied cooling from the CO_2 recovery installation for short periods during the week.

The graph shows that only a small quantity of CO_2 is liquefied by the CO_2 condenser. Since the cooling unit requires approximately half of the total energy, depending on how the system has been set-up, it is clear that the operational costs of the brewery have been greatly reduced after installing the Haffmans HRS-LiquiVap system. It typically takes 12 to 30 months for such an HRS LiquiVap system to pay for itself. It may be obvious that a simultaneity factor (CO_2 from fermentation vs. CO_2 consumption) plays a large role in the time it takes the system to pay for itself.



Conclusion

Breweries place an increasing amount of importance on saving energy and the three concepts which have been developed by Haffmans are an excellent means of contributing to this. By thinking outside of the box and linking different steps in the process, Haffmans has been able to create opportunities to reduce the operational costs in a brewery through the use of CO_2 recovery technology. The concepts have already been successfully implemented in breweries and practice has shown that the time it takes the systems to pay for themselves is very economically interesting.