

Thinking outside-of-the-box reduces operational costs

SAVINGS POTENTIAL | Breweries are seeing an increasing amount of pressure put 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 BV in Venlo/NL has developed three concepts for reducing costs through the use of CO₂ recovery technology. The approach presented here has a cost savings potential of up to 60%.

This not only concerns reducing costs by producing CO₂ at a cheap price. Haffmans looked further than just the CO₂ recovery process and by thinking outside of the box, a number of interesting possibilities were exposed.

CO₂ recovery

Before discussing these possibilities, let's have a look at how CO₂ is recovered. CO₂ is produced during fermentation. Any foam residue is removed in a foam separator and the CO₂ 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 H₂S and DMS from the CO₂ and the drying agent removes moisture from the gas. Once the CO₂ has been dried, the gas can be cooled in a condenser without the risk of freezing. CO₂ liquefies at low temperatures, whilst other gases (O₂ and N₂) will not liquefy during condensation. As a result of the extraction of the non-condensable O₂

and N₂ gases, this step has a substantial effect on the purity of the CO₂. The liquefied CO₂ is stored in a storage tank, vaporized again and finally supplied, at the desired pressure, to the breweries for processes that require CO₂, such as water degassing and carbonization.

Process links

CO₂ 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 CO₂. There are a number of reversible processes in the recovery process. CO₂ is first liquefied, and in the next step 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. Consecutively, three systems for recovering energy during the vaporization of CO₂ are presented, all of which have been developed by Haffmans:

- 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 the 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 used for cooling compressors. On the other hand, there are also processes which require energy, such as the vaporization of CO₂.

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

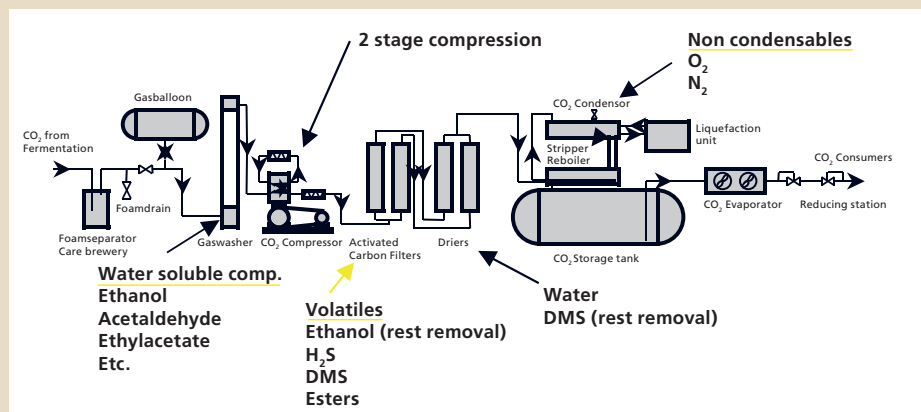


Fig. 1 Scheme of CO₂ recovery by Haffmans

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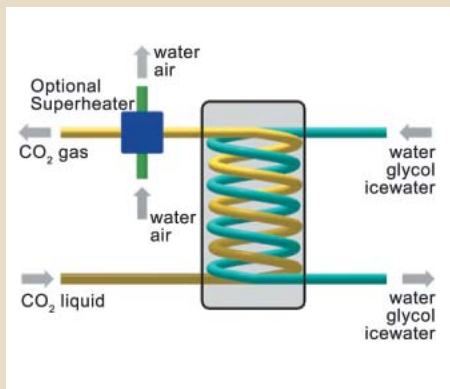


Fig. 2 Heat Recovery System – Direct

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 CO₂ is passed to the other side of the heat exchanger and, as a result, CO₂ will be vaporized and (hot) return glycol will be cooled. Possible agents to be used are glycol, iced water or cooling water. However, if glycol or iced water is used, the vaporized CO₂ must receive additional heating. Such a system quickly pays for itself. An example of a brewery using this system is given below. In this brewery, CO₂ is vaporized with 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 Euro/kW;
- Costs for steam: 0.017 Euro/kg of steam.

The amount of investment of the Heat Recovery System for this particular brewery paid for itself within 19 months. In general, such systems pay for themselves within 12 to 24 months, although this depends various factors, such as the capacity of the HRS system, the costs for glycol and steam, and the number of operating hours.

Haffmans Heat Recovery System – Indirect

If breweries use NH₃ to cool processes, either directly or indirectly, this NH₃ can also be used as an energy source in a Heat Recovery System. However, in case of a leak, CO₂ and NH₃ would come into contact with each other (cross-contamination). The result 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 case of a leak scenario, the second heat exchanger forms a physical barrier between the CO₂ and the NH₃. However, regarding the low temperature of the NH₃, additional heating is required. Haffmans has also tested this system in practice. The large advantage that cross-contamination is not possible requires larger investments 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 operating hours.

Haffmans Heat Recovery System – LiquiVap

For the third and last concept, Haffmans makes effective use of irreversible processes within the CO₂ 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 CO₂ recovery can be reduced by up to 60%. A large quantity of energy must be extracted from the process during the liquefaction of CO₂. After it has been stored, a lot of energy is required again for vaporizing the CO₂. 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 CO₂ whilst using hardly any energy for cooling. If CO₂ production and consumption take place simultaneously, there is an immediate energy saving because the extracted CO₂ can then be used to liquefy the CO₂.

At times when there is no CO₂ production or consumption, it is possible to liquefy or vaporize CO₂ 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. This system has also been installed and undergone extensive testing at a brewery with an annual capacity of 2 million hectoliters. Besides a number of different beers, this brewery also produces a considerable quantity of soft drinks and

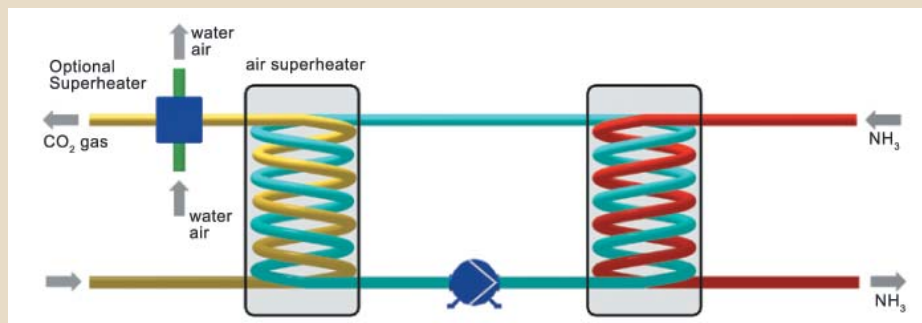


Fig. 3 Heat Recovery System – Indirect

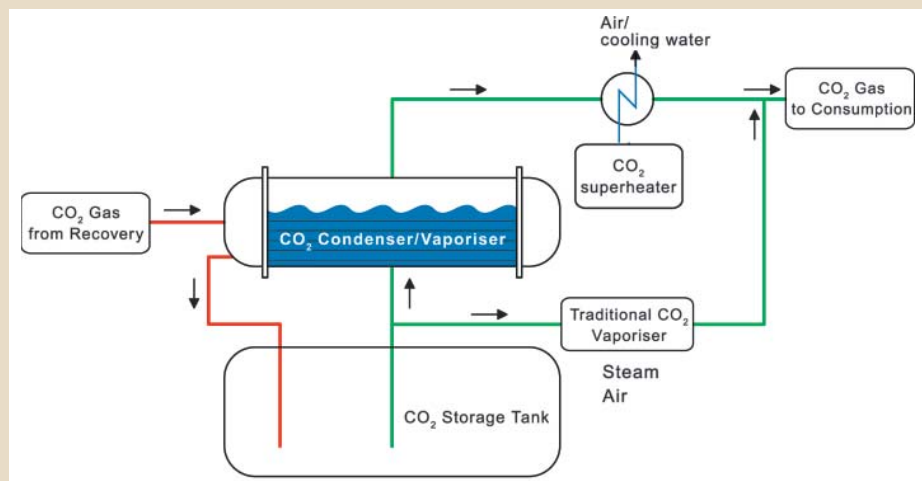


Fig. 4 Heat Recovery System – LiquiVap

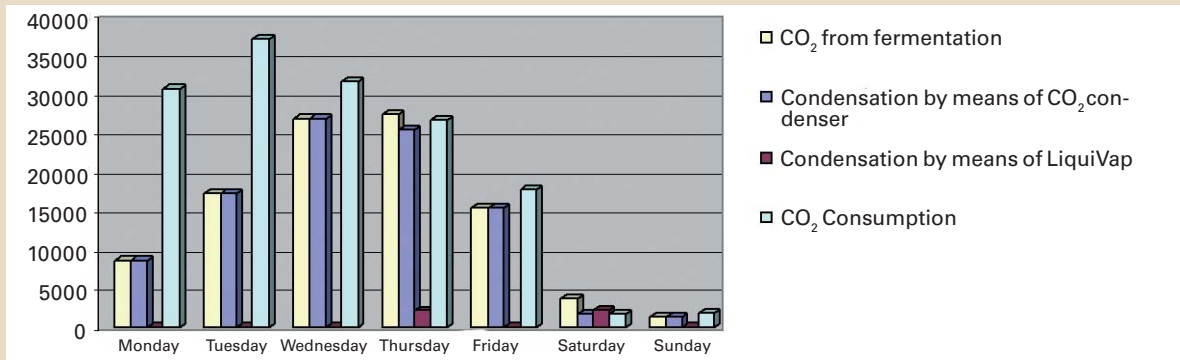


Fig. 5
CO₂- Production and
CO₂- Consumption

other alcohol-free products. The results are very positive. The expectations at the beginning of the project have been exceeded easily. Since using the HRS-LiquiVap system, the brewery has saved energy for a number of processes, namely:

- CO₂ condensation energy with the consequent release of heat to the centralized brewery cooling system linked to it;
- when pre-cooling the cooling water;
- the energy necessary to vaporize CO₂ (steam).

The diagram (Fig. 5) indicates which part of the CO₂ is liquefied using the HRS-LiquiVap (blue bars). These bars indicate where the savings have been made. The purple bars indicate condensation by means of the CO₂

condenser. The diagram below shows that the brewery has to use the initially supplied cooling from the CO₂ recovery installation only for short periods during the week. The graph shows that the CO₂ condenser liquefies just a small quantity of CO₂. 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 (CO₂ from fermentation vs. CO₂ 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 CO₂ from fermentation condensation by means of LiquiVap condensation by means of CO₂-condenser CO₂-consumption 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 by up to 60%. The concepts have already been successfully implemented in breweries and practice has shown that the time it takes for the systems to pay themselves, is economically very interesting.