EJECTOR COOLING SYSTEM CONQUERS THE MARKET

Thanks to new ejector technology, retailers can reduce the energy consumption of refrigeration and freezer units by one-fifth or more. Migros and Coop have been successfully applying the technology in Switzerland for several years. Supermarkets in other countries are also increasingly turning to the resource-conserving cooling technology, whereby Switzerland is a pioneer in its implementation and application. The Swiss Federal Office of Energy is supporting the commercial launch of the technology with contributions to three practically-oriented research, pilot and demonstration projects.

A cooling room of the Migros branch in Ibach (Canton Schwyz). The three textile tubes on the ceiling provide the room with + 1 ° C air. Photo: Frigo-Consulting

Report about the successful launch, implementation and application of ejector technology, based on a research and two pilot and demonstration projects supported by the SFOE. The report has been published in the magazine Kälte Klima Aktuell (edition December 2017).

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Both large Swiss retailers use ejector technology to cool their foodstuff products. Left: The fish counter in the Migros branch in Ibach (SZ). Right: View into a refrigeration unit in a Coop branch in Laupen (BE). Photos: Frigo-Consulting

Food markets must be modernized and updated every ten to fifteen years. About three years ago, a large Migros branch in Ibach (SZ) became due for a renovation. The managers of the Migros cooperative took advantage of the renovation of the Mythen Center to technicallly upgrade the refrigeration system: In 2014, a so-called ejector was installed to cool the 170 meters of refrigeraters and freezers, as well as the 280 m^2 of refrigerated and freezer rooms that the supermarket branch used. The ejector is an additional element of carbon dioxide (CO_2) operated refrigeration system. With the relatively simple component, Migros succeeded in permanently reducing the electricity consumption for refrigeration by 23%. For the innovation, the Migros branch received in 2015 the prestigious German EHI Energy Management Award.

Ejector is Now a Planning Standard

The installation in the Mythen Center marked entry of the ejector technology into the commerical market. Since then, Migros has equipped several dozen food markets with the technology. "Today, ejectors are integrated into the planning of cooling technology as standard for the renovation and new construction of Migros stores whenever they are economical," says Daniel Duss, Head of Construction and Technology at Migros Cooperative in Lucerne. Competitor Coop relies on the technology as well. "Refrigeration needs in food markets accounts for about half of the electricity consumption, which is why the ejector makes a significant contribution to the reduction of energy consumption," says Thomas Häring, Head of Energy and Technology at Coop. Coop and Migros use ejectors in some 60 branches throughout Switzerland. The technology is now established, and about 30 other supermarkets will be adding the technology each year. The ejector is now used in every other supermarket refigeration technology upgrade. Particularly worthwhile is the investment in the ejector in medium and large markets. The pay-back times are between one and six years, depending on the size of the market.

According to estimates, several hundred ejector systems are currently in use, the majority of which are in Europe. As in the development of heat pumps, Switzerland plays a pioneering role in the market introduction of ejector technology. Frigo-Consulting AG, a planning office for refrigeration plants based in Gümligen (Canton Bern), has closely followed this development over several years. Based on scientific findings of the Norwegian research institute SINTEF, the first pilot plant in the Migros branch in Bulle (Canton Fribourg) was put into operation in 2013. Here, the ejector achieved a savings of 14%. The technology was then optimized (control technology, integration) and expanded from the cooling to the freezer area. In this mature form, the ejector was used from 2014 onwards in the Migros located at the Mythen Center in the canton of Schwyz. "We depended on the trust of the builder, because installation of the innovative tool should not jeopardize the operational safety of the refrigeration system or the business of the supermarket," says Frigo Consulting Project Manager Jonas Schönenberger, which was an important challenge in the pilot phase.

Push for CO_2 Refrigeration Systems

The Swiss Federal Office of Energy (SFOE) has supported the development of a market-ready product with one research and two pilot and demonstration projects (Bulle, Ibach). Stephan Renz accompanied the projects as head of the SFOE research program Heat Pumps and Cooling for a total of five years: "Refrigeration systems that rely on CO_2 instead of synthetic refrigerants are relatively young and had to establish themselves on the market in recent years. The support of the public sector created the prerequisite for the first users to use this new, sustainable technology, despite initial additional costs - and now they are benefiting from significantly lower costs." The fact that a large retailer such as Migros was involved from the outset, has significantly supported the spread of the technology in the refigeration market.

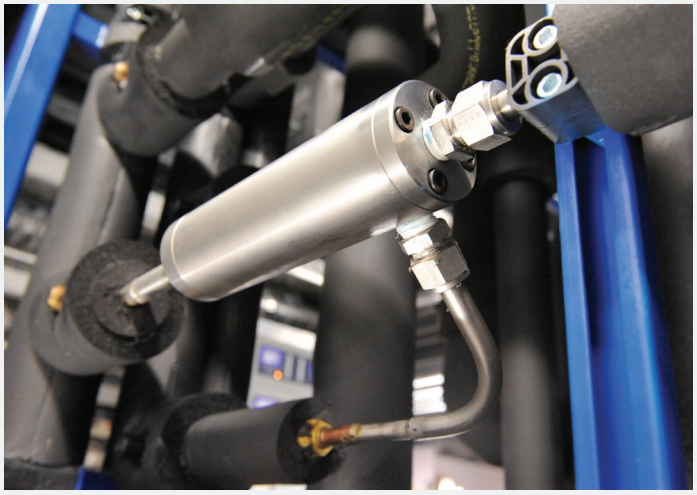
In Switzerland and the European Union, the synthetic refrigerants used so far are increasingly being banned due to their high greenhouse gas potential. Synthetic fluorocarbons (HFCs) have a 1000 times stronger greenhouse effect compared to the natural refrigerant CO_2. Thanks to optimization by the ejector technology, CO_2 remains a thriving refrigerant. This also has a positive effect on the environment because retail refrigeration systems over the years release five or more percent of the refrigerant into the environment through unavoidable leeks. Promoters of the ejector technology envisage further improvements in the environmental balance as refrigeration systems can be dimensioned even smaller thanks to ejectors. The relatively energy-intensive partial load operation of systems could thus be reduced. Thanks to a rapid further development of the technology and increasing commercial availability of ejectors, it is expected that the technolgy can be soon applied to units with cooling capacities 50 kW (today: 100 kW).

Significant Savings Potential in Europe

Industry, trade and services are responsible for about 60% of total electricity consumption in industrialized countries as well as in Switzerland. With the consistent use of ejector technology, the cooling sector can make a significant contribution to electricity savings. "While we achieve savings of 20 to 30% in Switzerland thanks to an ejector, 30 to 40% are possible at sites with less mature predecessor systems, depending on the building, the load profile, the waste heat recovery and the site climate," says Schönenberger. In Europe, according to an estimate, there are 9,000 to 10,000 CO_2 refrigeration units, which could achieve considerable energy savings by installing an ejector. Thanks to ejectors, CO_2 can also be used as a refrigerant in warmer countries. Around 80 to 90% of the cooling systems in European supermarkets do not yet use the environmentally friendly refrigerant. By retrofitting units, the owners of the markets could realize a considerable energy and financial savings potential of up to 40%.

In the coming years, the METRO Group (Düsseldorf) intends to take this step towards sustainability and resource efficien-

HIGHER TEMPERATURES IN THE COOLING UNIT



The ejector (photo) is a component in the cooling circuit of refrigeration plants that use CO_2 as a refrigerant. Thanks to the ejector and the associated parallel compressor, the coolant must be cooled down to a minimum: temperatures of -2 ° C (instead of -8 ° C previously) are necessary for refrigerated shelves, -25 ° C (instead of -32 ° C in older systems) for deep freezing. This allows the cooling circuit to be operated with lower power consumption.

Ejectors are produced by the suppliers of the refrigeration plants themselves or are available as components from manufacturers such as Wurm Switzerland (Reutlingen / Winterthur) or Danfoss (Nordborg / Denmark). Depending on whether the ejectors are manufactured in Switzerland or abroad, approximately 80 to 50% of the revenue comes back to Switzerland. One can only assume that other component manufacturers recognize the potential of the technology and are ready to get on this train. BV

Ejector technology is increasingly being used in other European countries: METRO's Cash&Carry market in Beverwijk (NL). Photo: Frigo-Consulting

cy in its 750 Cash & Carry wholesale markets. While nearly every tenth supermarket uses exclusively the refrigerant CO_2 for cooling, METRO plans to switch all of its markets to natural refrigerants and the ejector technology by 2030. Large markets in the Netherlands and France have already been equipped with the technology, in 2018 two more will follow in Poland. "METRO AG has formulated a technical guideline to establish ejector technology as a standard throughout the supermarket chain," says Olaf Schulze, Director of Energy Management at the publicly traded wholesale and retail company. The METRO manager can draw on the Swiss experience during implementation. On the occasion of an informational tour, he recently visited the Migros branch in the Mythen Center Ibach. "With the ejector, the Swiss retail store sets a good example," says Schulze.

↗ **Final reports** on the research and the two pilot and demonstration projects of the SFOE can be found at: http://bit.ly/2y13YOe

↗ For **information** on the project, contact Stephan Renz (renz.btr[at]swissonline.ch), head of the SFOE research program Heat Pumps and Refrigeration, and Dr. Josef Känzig (josef.kaenzig[at]bfe.admin.ch), head of the SFOE program Knowledge and Technology Transfer.

↗ For further **papers** on research, pilot, demonstration and flagship projects in the field of heat pumps and refrigeration, please visit www.bfe.admin.ch/CT/WP-Kaelte.

↗ The ejector has been gradually improved over recent years. Its functional principle is explained by an **info-clip** created on behalf of the SFOE: http://bit.ly/2x1KdH3

„OUR EXPECTATIONS OF THE EJECTOR HAVE BEEN FULLY MET"

Refrigerators and freezers in food supermarkets consume a lot of electricity. Over the last three years, a new technology has become established in the market, which enables refrigeration units to use 30% less energy. During the market launch of this so-called ejector technology, Migros played a pioneering role. Daniel Duss (58), trained dipl. Architect HTL and today Head of Construction and Technology at the Migros Lucerne cooperative, is interviewed:

Mr. Duss, the ejector technology has been used for three years in the Migros Mythen Center in Ibach (SZ). By how much was the energy use of refrigerators and freezers reduced?
Migros modernized the shop and the restaurant in the Mythen Center in 2014, the supermarket has been expanded from an MM to an MMM branch with a retail area of 3500 m^2. During the course of the expansion, the central refrigeration system was replaced, which cools all refrigeration and freezer units. The new system uses as refrigerant, environmentally neutral carbon dioxide (CO_2), which replaces the previously used synthetic, environmentally harmful refrigerants. We also equipped the CO_2 refrigeration system with an ejector as part of a pilot project. The combination of ejectors and parallel compressors makes it possible to utilize the energy previously lost during pressure release. Compared to the conventional systems used a few years ago, we achieve a savings of approximately 25% of the electrical energy use.

Have you acheived this savings during all three years of operation?
Yes. The ejector, initially introduced as a pilot, has proved its worth and is now reliably in operation. The refrigeration system cools about 170 meters of refrigeration and freezer units as well as a total of 280 m^2 of cooling and freezing area in the supermarket branch. For cooling, 250 kW of cooling capacity is required, which is provided in the Mythen Center by two refrigeration systems equipped with ejectors. Our expectations of the ejector have been fully fulfilled.

Innovative technologies usually have a few hiccups along the way...

In this case we have not experienced any specific problems. As with any new system, there was a two to three-year phase of operation optimization, during which the system was fine-tuned. For us, it was vital that the refrigeration system functioned reliably from day one so that foodstuff quality could be guaranteed around the clock. The refrigeration system was therefore designed in such a way that we could have operated it without an ejector at any time, if an ejector became faulty or caused problems. This did not happen.

What motivated Migros at the time to try the new ejector technology?
The main motivation was the promise from our specialist planners that the ejector can significantly save energy. In this way, we contribute to sustainability and environmental protection. As a large company, Migros has made an important contribution to bringing the innovative technology from the developers labs to commercial and industrial users. We have taken on a pioneering role, and we have taken others with us. In addition, many others benefit from the technology. Product cooling requires a lot of energy; with the ejector we save a lot of electricity and thus also money. Annual maintenance of the system requires slightly more effort than conventional systems, because CO_2 ejector systems are more complex and more demanding for the staff.

The SFOE has financially supported the development of ejector technology with one research and two pilot and demonstration projects. To what extent was this support of public funds helpful to Migros?
We decided early to construct a new cooling system. During the pilot phase, non-redeemable additional costs were incurred in the Migros branch in Bulle (FR) and later in the Mythen Center near Schwyz. The SFOE proved to be an important partner here. After the completion of the development phase, ejectors are now profitable and are widely deployed, so elegibility for support contributions has lapsed.

After Ibach, has Migros equipped further supermarkets with the technology?
Currently, Migros Lucerne operates three systems, and several dozen Migros stores are equipped with it nationwide. Migros uses ejectors in renovated locations that are large enough for these systems to operate economically. This is usually given for larger branches of the MM and MMM format. For small branches up to 1500 m^2, the systems are usually not used as a rule; here the benefit is too small compared to the investment costs. Further development of the refrigeration units also influences the engineering of central refrigeration systems.

How do you forsee the future of ejector technology?
Today, ejectors are evaluated as part of the standard planning process for refrigeration technology during renovation or newly constructed Migros stores and are included in stores where it makes sense to install them. Should more efficient technologies become available in the future, we will continue to pursue further development steps at Migros.

PILOT, DEMONSTRATION AND FLAGSHIP PROJECTS OF SFOE

The market introduction of the ejector was made possible by, among other things, two pilot and demonstration projects with which the Swiss Federal Office of Energy (SFOE) promotes the development of economical and rational energy technologies and encourages the use of renewable energies. The SFOE supports pilot, demonstration and flagship projects with 40% of the eligible costs. Applications can be submitted at any time.

↗ **Information**:
www.bfe.admin.ch/pilotdemonstration
www.bfe.admin.ch/leuchtturmprogramm

Report and interview: Dr. Benedikt Vogel, on behalf of the Swiss Federal Office of Energy (SFOE)
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