HAARSLEV™
PAPER

MEAL COOLING OPERATIONS

An often-overlooked part of any rendering line

Familiar – yet not …

Meal coolers have been a standard part of industrial rendering lines ever since the 1980s.

So long, in fact, that many people take them for granted. And forget about why they're important – and why there can be *big* differences between different types of meal coolers, and the benefits they can provide.

There are a lot of different factors to be taken into account when you're considering whether or not to include a meal cooler in your rendering setup. If so – which, and why?

This Haarslev Paper is intended to assist you through the maze of different options, as well as helping give you an overview of key pros and cons, to help you in your decision-making.

What a meal cooler really is

The basic purpose of a meal cooler is to bring down the temperature of rendered meal when it exits the cooking/defatting process, to prepare it for subsequent milling operations.

It also offers other important advantages, based on keeping-the temperature of meal products stable after drying.

Most modern meal cooler designs are basically a long drum with a rotating agitator inside. The agitator continuously scoops up the hot meal (which is usually at temperatures of 90–110°C) from the bottom part of the drum and throws it upwards into the path of the cooling air which is being drawn through the drum under control by a centrifugal fan. The meal gradually progress from the inlet towards the outlet end in counter-direction to the direction of the cooling air and eventually emerges much cooler at the outlet.

This crucial cooling air can either be ambient air or flows of air from suitable processes elsewhere in your plant – preferably as cold as possible.

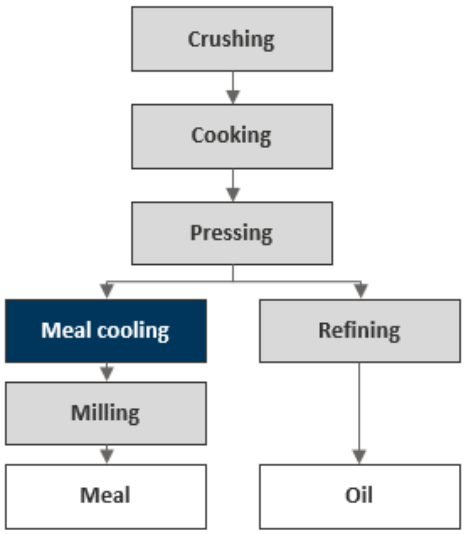
The aim is to enable effective cooling via best possible contact between the meal still hot from the dryer, fat screw press or other equipment and the flow of cooler air.

More complicated than it looks

Meal coolers may *seem* like a relatively simple piece of equipment.

However, the process of cooling the meal is actually quite complex. It requires considerable specialist knowledge about parameters that include meal composition, air flow, thermal gradients, electronic sensors, powder volatility, antioxidant chemistry, bacteriological analysis, etc.

Just like a good old internal combustion engine, meal cooler operations need keeping in tune. That's why the mechanical specifications of a meal cooler are only the beginning of the equation. No two setups work under exactly the same conditions, while inputs usually vary in specifications, and output criteria are constantly in flux, for commercial, qualitative and legislative reasons.



Why meal coolers are important

Poultry, fish, meat, blood or feather meal are some of the higher-value end-products from industrial rendering processes. This makes the processes involved in determining meal

quality, consistency and production costs relatively important in any commercial context.

Haarslev's worldwide rendering experience confirms that companies are all too often exposed to significant elements of risk associated with oxidation processes within the meal itself, as well as having to deal with potential condensation arising inside the processing and storage equipment.

These kinds of situations frequently result in unpredictable patterns of bacteriological activity in the meal, and have a direct impact on product quality. Any kind of product degradation impacts the revenue potential for your rendering operations, as well as levels of customer satisfaction and brand loyalty with regard to the meal products you deliver to your customers.

Poultry, fish, meat, blood or feather meal is usually very hot after processing – often reaching temperatures as high as 110°C.

Meal coolers are designed to reduce meal temperature to below 50°C, to stabilize the meal and avoid condensation.

Meal Coolers are relevant for both wet- and dry rendering processes. In particular the press cake from the dry rendering process is relatively soft right after the press and then "hardens" as it cools – or is cooled. The crisper and more brittle the meal is, the easier it is to mill. So optimal results at the hammermill are ensured by successful reduction of temperatures of the press cake by a prior cooling stage.

Do you need a meal cooler – or not?

First you need to consider whether or not to even think about a meal cooler of *any* kind.

Without a meal cooler, a company will normally be faced by issues like these:

1. Risk of meal getting contaminated
High temperatures inside meal handling equipment also make it more likely that condensation will form.

Crucially, combinations of condensation and high meal temperatures then also increase the risk of microorganism growths that contaminate meal passing through the system. This can put big dents in your profit margins.

2. Unreliable end-product quality
Meal composition varies widely, reflecting input specs as well as processing details. Blood content and a wide range of other factors are also important in helping determine end-product quality, because different materials and input specifications result in big variations in oxidation potential.

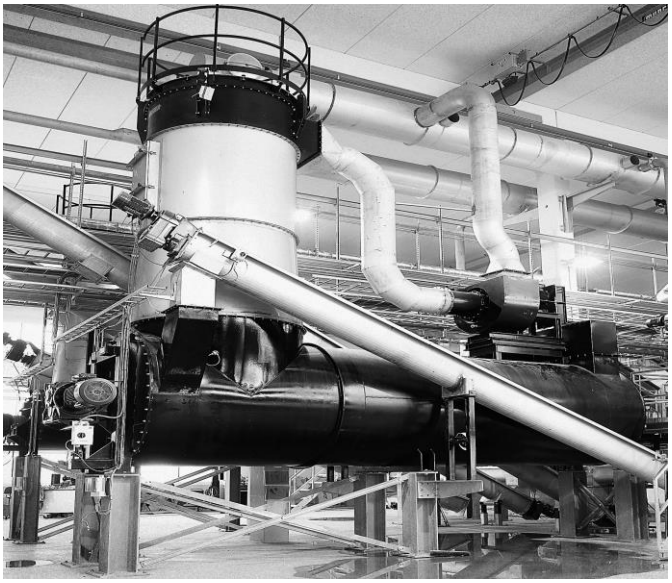
High temperatures within the meal accelerate such oxidation as well as other undesirable degradation processes. Most companies therefore add antioxidants to try to slow down and prevent such conditions. Higher FFA and oxidation levels mean that such antioxidants will have shorter term effects, resulting in a shorter end-product shelf life.
At higher meal temperatures, peroxide values also increase. This adversely affects the digestibility of the end product.

Regardless of cause, lower product quality impacts revenue, as well as denting the commercial reputation of any meal supplier.

3. Risk that the meal self-ignites
If a meal features certain specific combinations of temperature, fat content and moisture levels, spontaneous combustion *may* occur as a result of local overheating caused by oxidation.

There have been several unfortunate cases of industrial rendering lines in which this has actually happened. Such events usually reflect an overall lack of awareness and information about the exact conditions inside

meal processing equipment and storage tanks or facilities.



4. Poor hammer mill performance
High meal temperature has a significant negative effect on milling performance. If the meal enters at temperatures of e.g. above 50°C, the fatty component becomes more liquid, making the press cake stickier.

Stickier meal reduces the throughput capacity, increases down-time for cleaning or unblocking equipment and increases wear and tear on the equipment, as well as energy consumption for the entire milling process.

5. Reduced meal screen capacity
If you are screening your meal before and/or after it passes through the hammer mill, the output capacity of your screening setup will also be greatly affected by the meal temperature.
Just as with the hammer mill itself, a higher meal temperature normally leads to a lower throughput.

6. Insufficient control of key processes
Without being able to adjust and control temperatures inside your meal flows, you really only have limited control over what's going on inside your equipment and storage facilities.

Such unknowns are usually seriously bad for business. Even small interruptions and irregularities in meal production and processing can quickly impact customer satisfaction as well as your revenue stream, and end up costing you big money.

Insurance policy – or control guarantee?

Some people liken installing a meal cooler to having an insurance policy, involving a known equipment expenditure to balance out the risk of potentially extremely costly major glitches that might never actually happen.

The Haarslev approach is to consider it more in terms of maximizing control of what's happening during your rendering operations and minimizing as many sources of uncertainty and risk as possible. These are the basics of good business management, really.

A question of control
Traditional stand-alone "engineering iron" is increasingly considered a thing of the past.

Nowadays, individual items of equipment are rarely considered as stand-alone setups – they're a part of larger integrated systems in which all the different parts are inter-dependent, each contributing to (or hindering) good results in different ways.

Performance and profitability depend on the weakest link in the chain, and effective decision-making depends on full information about operating conditions, so these can be tweaked, improved and fine-tuned to your company's advantage.

A question of quality
Haarslev has decades of solid, practical experience in dealing with processes in industrial rendering operations.

This means we are well aware that – unfortunately – some degree of product degradation is pretty much an unavoidable feature of most rendering setups.

Anything that happens in a rendering or fish meal plant after drying is critical to ensuring low levels of bacteriological activity in the meal. That's why the meal cooler (and any

associated conveying equipment) plays a critical role in consistently ensuring the revenue-earning value of your meal end-product – the basic calculations on which the business case for your investment was probably built.

Future thinking
In modern commercial rendering setups, more and more decision-makers want to be sure of having the best possible end-to-end control of operating conditions – accompanied by all the necessary documentation and operating data.

Reliable data about operating conditions is vital for the modern monitoring and control systems used in forward-thinking processing setups, and for the increasing levels of automation often crucial for maintaining quality standards as well as customer satisfaction and profit margins.

Bigger decisions
A meal cooler isn't a stand-alone "island". In modern rendering plants, you can't simply take decisions about individual items of equipment in isolation, without considering the wider operating context.

Decisions about meal cooling systems and technology configurations involve a focus on whole systems and margin optimization, as well as the efficient, reliable running of end-to-end systems.

Equipment and Technology decisions

Alternatives to meal coolers?
There are, of course, alternative technologies and equipment that can provide some of the same benefits as meal coolers, in certain specific situations.

These include:

- **Curing bins** in which hot meal is temporarily placed to cool off prior to milling. Such systems normally only serve as a time-delay "buffer" in the overall process, and do not provide any active cooling of the product. In many cases, the use of curing bins can lead to a high risk of micro biological growth due to the often long retention time, combined with moisture from condensation.

  Basically, curing bins are in no way thermally efficient or obviously desirable – but they *are* cheap.

- **Cooling screws** in which the meal is cooled using a combination of counter-current air flow and the retention time in the screw itself.

  Cooling screws normally mean the meal spends much less time in the cooling process (the retention time) than specialist meal coolers, but they can still be a reasonable alternative for rendering plants with a relatively small output.

- **Water-cooled meal coolers**. These are normally a specialist alternative to air-cooled units, mostly for use in hot, humid conditions or if there are particular space limitations.

  Water-cooled meal coolers are normally designed as a vessel with an internal rotor – similar to meal dryers. The rotor consists of a series of hollow parallel discs mounted on a horizontal shaft. A cooling medium – usually water – circulates inside the discs while air is also drawn from inside the vessel. The air extraction is critical to prevent condensation and thereby micro biological growth.

  Water-cooled meal coolers are relatively expensive to operate, as a result of ineffective heat transfer between the discs and the meal.

  Nevertheless, this technology may still be a commercially or technically viable

alternative if you need really low meal temperatures, or if your plant has to operate in particularly high temperatures and/or with high levels of humidity.

All in all, however, Haarslev's worldwide experience shows that most operators of rendering operations normally opt for some form of meal cooler solution.

The question then becomes – which? As with almost all equipment decisions, there are almost always trade-offs between different systems, capabilities and budgets. For example, a water-cooled meal cooler can be combined with other appropriate equipment, such as cooling screws.

Meal cooler pros and cons

Water-cooled meal cooler		**Air-cooled meal cooler**	
Advantages	**Disadvantages**	**Advantages**	**Disadvantages**
Works independently from ambient air temperature with a smaller footprint	Relatively expensive because of equipment design, liquid cooling system, extensive plumbing, etc.	Works best when outside air is at lower temperatures	Doesn't work as well during high-temperature periods, or in high-temperature climates
Good if your rendering plant has to operate in a particularly hot and humid climate	Heat transfer between discs and meal is not very effective	Lower upfront purchasing cost	Relatively high maintenance cost when using air filtration systems, especially with meal that has a high fat content

We strongly recommend careful consideration of your distinctive operating circumstances, practical requirements and customer concerns – current as well as planned.

Other considerations usually include:

- Purchasing price
- Operating costs
- Available service capacity
- Air handling capacity
- Cooling water availability
- How much your customers prioritize consistent, reliable meal deliveries
- Your company's future capacity, process and technology plans
- Your commercial ambitions for the future

Where we stand

For over a century, Haarslev has been helping the world turn organic waste into valuable proteins and many other products we all depend on.

As one of the world's leading providers of technology for rendering and processing operations, meal cooling solutions and know-how are just one of the key capabilities we work with.

Context counts

Your meal cooling operations may involve Haarslev equipment – or not. You might even use equipment from a mix of different suppliers – it all depends on your operational history, your existing setup as well as your exact requirements and processing priorities.

We consider the bigger picture

Rendering and processing operations are often complex and challenging, and the different operations impact each other. There little commercial meaning in simply "selling" hardware, without looking at the broader operating context and the benefits we can help you achieve by putting the unique Haarslev know-how and experience to work.

Our core focus is on helping you identify the exact setup that'd be best for your company, its operations and its "bigger picture" priorities – both right now and in the future. And then to help you install, configure and calibrate each system and item of equipment to help optimize and fine-tune the end-to-end flow of your particular operations.

Updating or replacement?

It is sometimes possible to update and upgrade older, existing meal cooler installations to take advantage of new features and technical advances.

However, it's often a good idea to reconsider your current requirements as well as future needs in a wider context involving combinations of efficiency gains, environmental impacts and better control as

well as changing market expectations and legislative requirements.

This kind of broader perspective – assessing meal cooler operations as an integrated part of wider system operations – can provide much greater efficiencies as well as better end-to-end ROI in your rendering operations as a whole.

Haarslev recommends
We usually recommend an individual assessment of each setup, because there are *so* many different parameters, prioritizations and interactions involved.

Such assessments normally include:

- Effective documentation of the existing system's performance in terms of capacity and outlet temperature
- Determination of future requirements in terms of capacity, quality standards and technology
- Site surveys and/or 3D scanning of your interior spaces to determine exactly how much space is available for new equipment.

Improving well-known capabilities

Haarslev Industries has been manufacturing different kinds of meal cooler equipment ever since the late 1970s.

With more than 500 systems sold and installed worldwide, these designs have become well-known throughout the rendering industry, and have a good reputation for toughness and reliability.

In 2020, however, the Haarslev meal cooler range underwent a big rethink, a substantial redesign and a whole bunch of significant technical upgrades – and is now available as the Haarslev Continuous Meal Cooler.

This rethink of how we provide customers with effective meal cooling capabilities features a much wider range of equipment options, resulting in more configuration flexibility.

Haarslev Continuous Meal Coolers – overview of payoffs

You would normally install such meal cooler units to reduce the temperature of the meal passing from the drying or pressing stage and then to the milling stage for subsequent storage.

1. Safe storage

Controlled conditions in the meal entering storage make it possible to stabilize the meal and reduce the risk of much-feared spontaneous combustion. Safe storage means a big reduction in operating risks and the resulting need for preventive measures.

2. Clean meal

You get big benefits from better control over the conditions in the flow of meal into your company's storage facilities.
Controlled conditions – featuring less oxidation and/or condensation – help you prevent undesirable bacteriological growths or other imbalances that affect meal quality and market value.
This is a particular focus in the special Hygienic model, which we designed to be virtually self-cleaning.

3. Continuous cooling

Continuous processes are always more efficient than batch-based processes that involve constant interruptions.
You install these meal cooler units in line with your meal product flow, to ensure a continuous, uninterrupted process – and the greater efficiency that results from this.

4. Easy access

All Haarslev meal coolers feature easy access as standard. Maintenance and cleaning staff have quick access to all parts of the cooler for inspection, maintenance and cleaning.
This makes it easier – and also cheaper – to maintain hygiene standards and thereby product quality.

5. More efficient milling

Cooling helps make the processed cake more brittle, so it's easier to mill.

It also helps prevent any risk of your hammer-mills over-heating, with all the expensive process disruption and equipment wear and tear involved in that.
With this cooling system, you no longer have to worry about pre-conditioning your meal inputs, making your operations more versatile as well as helping trim costs.

6. Energy efficiency

These cooler units are configured to reduce energy consumption as much as possible, featuring smaller, high-efficiency motors, high-effect fans and agitator paddles designed to make the best use of all energy inputs.

7. Less waste, more profit

Efficient filtration options enable you to make sure less meal goes to waste, helping you improve yield results as well as operating margins.
Better control of overall conditions helps ensure better product quality, adding up to more revenue.

8. Connectivity and control

Both models are equipped with temperature and pressure sensors as standard.
These make for easy fine-tuning and monitoring, as well as seamless integration with other control systems throughout your processing operation.

There are now two separate versions of the Haarslev Continuous Meal Cooler, with very different configurations – Universal and Hygienic.

Different needs – different equipment

The Haarslev Continuous Meal Cooler is a straightforward continuous cooler system that keeps the temperature of meal products stable after drying.

There are two completely different versions. At first glance, the two configurations can look similar – but there are very important differences.

Continuous Meal Cooler – Universal

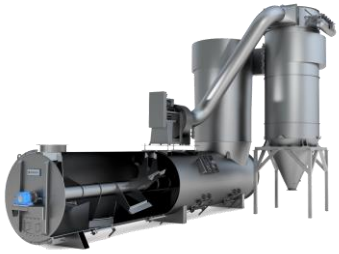
This model is specially configured for the cooling requirements in most standard processing and rendering setups working with poultry, fish or meat meal.

Continuous Meal Cooler – Hygienic

This special model of the new Haarslev Continuous Meal Cooler is made mostly of AISI 304 stainless steel, and is also available in a special acid-resistant AISI 316 configuration.

The drum features a polished agitator with all the surfaces smoothed and edges rounded to help prevent “dead spots” and avoid the accumulation of meal residue that might result in revenue-destroying bacterial contamination of your end-product.

The shaft that the agitator rotates around is sealed, and specially designed for easy cleaning that makes sure of keeping hygiene at the highest possible levels.



Advantages of the Hygienic model

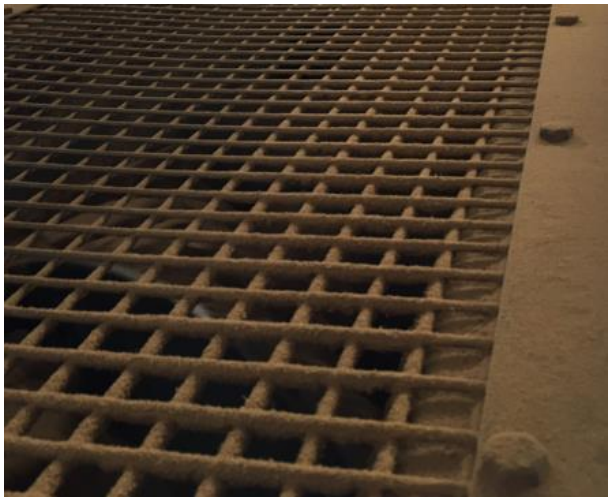
This model is designed to give companies specific advantages and benefits, including

- Designed for high-hygiene processing, right from the outset
- The design has been reviewed and approved by leading pet food manufacturers
- End-to-end focus on hygiene helps you prevent kinks or holes in your company's hygiene chain
- Exceptional hygiene helps boost revenue and price premiums in a fiercely competitive market.

Separators or filter bags?

All Haarslev Continuous Meal Cooler models are available with either cyclone separators or a self-cleaning bag filter system.

Whether you use a cyclone separator or a self-cleaning bag filter system usually depends on how much meal dust you can deal with in the air flow leaving the meal cooler.
Below you can see an example of a plant where meal residues are not filtered well enough and hence ends up in the plant



Cyclone separators are always the cheaper option, but result in more meal being lost. Too much residual dust in the air is likely to result in downstream odor issues, blockages or even fire hazards that can be difficult as well as costly to tackle.
Cyclone solutions provides a reduction of dust in the air to 2000-100 mg/Nm3 depending on the particle size in the products that are being cooled.

Self-cleaning (but not maintenance free!) bag filter systems tend to be more expensive, but effectively separate the meal from the flow of air, keeping your meal waste to a minimum. This kind of filtration solution will achieve lower dust levels. Here the reduction of dust in the air is typically less than 10 mg/Nm3.

In Haarslev's experience, the up-front price difference between a cyclone and a self-cleaning bag filter system is usually around 15%. But, of course, there are also other parameters that enter into your equipment and implementation decisions.

Fitting them in

Let's be straight about this – Haarslev Continuous Meal Coolers *are* fairly big.

Cyclones and bag filters that are a key part of such installations also require some height.

With cyclone separators, you need between 3.6 meters to 9.6 meters of free height from our smallest to largest model. When using a bag filter system, the height requirements are 3.4 meters to 8.0 meters.

However, if there are particular height limitations, we can customize the system with the cyclone separator or bag filter system placed side-by-side with your new meal cooler.

HAARSLEV™

Processing Technology

PROCESS
IS POTENTIAL

HEAD OFFICE

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