Solutions for the Dairy Processing Industry

PRODUCT RECOVERY AND EFFLUENT TREATMENT SYSTEMS

Ultraspin systems are well suited to the dairy industry because the separators:
- Have no moving parts
- Require little or no maintenance
- Are simple and easy to operate
- Have a very small space requirement

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HOW ULTRASPIN CAN BENEFIT THE DAIRY PROCESSING INDUSTRY

EXECUTIVE SUMMARY

This document highlights the opportunities to improve dairy plant effluent treatment systems. The problems associated with milk solids contamination of wastewater are covered. The benefits of an Ultraspin separator are discussed, including the potential return on investment, and a performance comparison with other separator types is made. More details are given about the separator, including: how it works, what a typical system consists of and process considerations. The document concludes with a sample method to calculate of return on investment and a list of some current installations.

WHO ARE ULTRASPIN?

Ultraspin design and supply high performance separation systems. Our systems use hydrocyclone technology to separate out oils, fats and suspended solids from process and effluent streams. Due to the combined characteristics of high performance and simplicity, our clients are able to make process separations in more cost effective ways.

Ultraspin manufactures a range of products specific to the dairy industry. There are three main duties where the separator can be used in dairy processing:

1. Oil, fat and light solids recovery
2. Heavy solids recovery

Through consultation with industry, research and development, and the experience gained from many successful installations, Ultraspin Technology has the know-how to provide efficient separation packages to the dairy processing industry.
CHALLENGES FACED BY THE DAIRY INDUSTRY

This industry faces a number of challenges associated with the separation of fat and suspended solids by-products. The size of the dairy industry combined with the high volume and strength of effluent generated is a major environmental concern. Discharge of poorly treated effluents steams to surface water or land causes contamination of streams and waterways, excessive concentration of nutrients and land degradation in the form of excessive nutrient loading, high salinity, low/high pH, groundwater contamination and clogging of soil by fats/solids.

Modern effluent treatment systems usually consist of a number of treatment stages. Typically they are arranged as Primary, Secondary, and sometimes a Tertiary system. The Primary stage consists of coarse screening of solids and collection of the effluent in a balance tank. The Secondary stage removes free and emulsified fats, oils and suspended solids. The effluent treatment system’s Secondary stage must reduce the overall operating cost and thus enhance the efficiency of Tertiary stages.

The Ultraspin separator is usually used as a Secondary separator. In some cases it can produce sufficiently clean water for direct discharge.

If the Secondary treatment system performs poorly it can cause the following:

Fat Layers
- Unsightly fat layers, which affect system efficiency

High Chemical Usage
- High use of chemicals for treatment systems such as DAF and IGF which are not only costly but contaminate recovered product.

High Maintenance
- General maintenance of Tertiary treatment is high.

High Operating Costs
- Some water treatment systems require a large amount of operator attention. Many chemical treatment systems, such as DAF, IGF and similar, will not function efficiently unless they have full time operators. Systems often require regular maintenance and cleaning.

High Disposal Costs
- Sewerage, Trade Waste or EPA disposal charges

High Desludging Costs
- High cost of handling DAF sludge, desludging pits, lagoons, ponds, etc. Solids disposal charge.
How Does the Ultraspin Fat Separator Work?

Process water contaminated with fat, oily and/or light solids mixed with water enters the separator through a tangential inlet. The flow is directed into a vortex. As the flow is forced down the liner it takes up a helical form along the inner walls. It is accelerated in the concentric reducing section to the high velocities required to create the strong centrifugal forces that promote rapid separation. These velocities are maintained along the liner, frictional losses being offset by a gradual reduction in cross section area throughout the tapered section.

The denser water moves to the wall of the separator and is removed at the downstream clean water outlet. Less-dense contaminant is drawn into the low-pressure core and, by applying a backpressure to the treated water outlet, flows back up the separator to be removed at the upstream outlet orifice.

The vortex and reverse flowing core extend down into the tail section of the separator, increasing the residence time and allowing smaller, slower separating oil and grease droplets to migrate to the core.

The centrifugal force inside the Ultraspin separator is more than 1000 times the force of gravity. This is the primary reason why our separators can separate so effectively and in such small packages. This separator is also used to de-aerate dairy process flows. Instead of forming an oil core the emulsified air forms an air core and exits the top of the separator in the same fashion as the oil/fat.

Inlet head for a high temperature fat removal separator. Notice the two tangential inlet holes and the small hole in the centre of the head where the fat is removed.
**HOW DOES THE ULTRASPIN HEAVY SOLIDS SEPARATOR WORK?**

The heavy solids removal separator works on the same principal as the oil/fat separator although it is physically about half the length.

A mixture of heavy solids particles and a lighter liquid like water, whey or milk enter through a tangential inlet. The flow is directed into a vortex. This vortex is accelerated in a concentric reducing section to the high velocities required to create strong centrifugal forces.

The denser solid particles are forced to the wall of the separator by these centrifugal forces and exit via an underflow outlet. The solids depleted stream exits the separator at the opposite end via the overflow.
THE BENEFITS OF AN ULTRASPIN SYSTEM

The Ultraspin separator is powerful, compact, simple, non-chemical, low cost and easy to maintain. It separates out emulsified fat and suspended solids efficiently and quickly. Its power is evident by the speed and high efficiency of separation. The actual time for separation to take place within the separator is two seconds. The quick recovery of fat is desirable to keep free fatty acids low. Typically 75-95% of fat and 65-75% of heavy suspended solids can be recovered from dairy effluent streams. These characteristics make it a sensible choice for Secondary treatment. The inherent benefits of this separation technology are:

Recovery and Reprocessing
- Clean (non-chemical) recovery of milk solids that contain valuable milk fat, protein, lactose and lactic acid.
- Non hygienic fat and protein can be reprocessed

High Temperature
- Separation is enhanced at elevated fluid temperatures. Water can be treated immediately without cooling time or the need to pass through a heat exchanger.

Cleaner
- Reduction in costly pump outs, trade waste charges and less sludge cleaning.

Improved Overall Treatment
- Consistent inlet stream to tertiary treatment
- Electrical power for aeration of ponds reduced
- Less maintenance
- Increased efficiency of tertiary stage

Dairy Specific
- Can be made hygienic and C.I.P. cleanable

Low Acquisition Cost

Simple Installation/Small Space Requirement

Simple Operation
- Minimal or no demands on operation and maintenance staff. Operators will have more time for other duties because they will not be dealing with the effects of fats and solids carryover to other more complex treatment systems. Also, the operation of a system only contributes minimal noise (noise of the pump).

Low Maintenance
- Pump is the only moving part
- No or minimal cleaning
- Robust stainless steel construction
APPLICATIONS FOR DAIRY PROCESSING

Fat and Oil Separator (typical removal of 10\(\mu\)m with densities of 600 to 980\(\text{kg/m}^3\))
- Non-hygienic fat and oil recovery for re-sale
- Pre-treatment before anaerobic/aerobic digesters
- Fat reduction with DGF, IGF flotation treatment

Solid/Liquid Separators (typical removal of \(\geq 2\mu\)m with densities of 1100 to 3000\(\text{kg/m}^3\))
- Suspended solids removal from factory site effluent water
- Hygienic sludge and solids recovery from C.I.P. detergent reclaim and washing systems

Hygienic 30m\(^3\)/h milk system

Typical samples from fat/oil separator. From left to right: inlet, fat concentrated stream (5% of total flow) and treated stream (remaining 95% of flow)
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**HOW DOES IT COMPARE?**

Typical load reductions for secondary treatment systems are:

<table>
<thead>
<tr>
<th>System</th>
<th>Tank</th>
<th>DGF/IGF (no chemicals) *</th>
<th>DGF/IGF (24 hr operators and full chemical treatment) *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil and Grease % reduction</td>
<td>70 to 82</td>
<td>50 to 60</td>
<td>60 to 80</td>
</tr>
<tr>
<td>Suspended Solids % reduction</td>
<td>60 to 70</td>
<td>50 to 60</td>
<td>50 to 65</td>
</tr>
</tbody>
</table>

**”** Reference

1. *Dissolved Air Floatation for Abattoir Wastewater*; D Lovett and S.M. Travers CSIRO
2. *Treatments of Fatty Effluents*; P Grant PhD Unilever

**ULTRASPIN SEPARATOR PERFORMANCE**

Ultraspin has conducted performance tests at various dairy manufacturing sites on effluent water upstream and downstream of an installed Ultraspin system. Independent laboratory analysis of a multitude of samples proves that the following average separation performance can be achieved:

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil &amp; Grease</td>
<td>≤ 95</td>
</tr>
<tr>
<td>BOD</td>
<td>30 to 60</td>
</tr>
<tr>
<td>Suspended Solids</td>
<td>60 to 85</td>
</tr>
<tr>
<td>Phosphorous</td>
<td>30 to 60</td>
</tr>
<tr>
<td>Total Nitrogen</td>
<td>20 to 40</td>
</tr>
</tbody>
</table>

Ultraspin have portable test units that can be used to determine how well the separator will perform on specific dairy effluents. This provides an accurate indication of how a full size system will perform.

**RETURN ON INVESTMENT**

An Ultraspin separator will save you money.

- Income and savings from recovered product
- Reduction in operator time
- Reduced or eliminated water treatment system maintenance
- Saving in system maintenance and efficiency
- Savings in Tertiary treatment system operating costs

Typically return on investment with Ultraspin systems are less than two years.
TYPICAL RECOMMENDATIONS

ULTRASPIN SOLUTIONS DESIGNED TO ADDRESS INDUSTRY NEEDS

ULTRASPIN FATTY AND OILY WATER TREATMENT SYSTEM

FACTORS USUALLY CONSIDERED BEFORE MAKING FIRM PROCESS DESIGN RECOMMENDATIONS

Site Testing (larger jobs with existing installations)
- On-site tests are sometimes conducted to determine the best location and design of the Ultraspin water treatment solution.

Current Effluent Water Treatment System
- Ultraspin studies the details of any current or proposed effluent treatment system. This assists us in determining how best to integrate the Ultraspin solution. Typical considerations are:
  - Effluent water flow (peak, normal, design)
  - Process flow diagram (PFD)
  - Process and instrumentation diagram (P&ID)
  - Temperature at locations in effluent process
  - Feed pump types and details
  - Tertiary treatment systems, DAF’s, Lagoons types and details
  - Collection pit details. Dimensions, inlet - outlet configurations etc.

Chemical Usage
- Details of chemicals currently feed into the effluent water system
  - Type
  - Concentration
  - Daily usage
  - Materials Safety Data Sheet

40m³/h dairy effluent water treatment system installed at Kraft, Leitchville, with heated fat storage tank
**TYPICAL PROCESS DESCRIPTION**

Ultraspin prepares process design recommendations on a case-by-case basis. Typical features of the designs are:

- The purpose of this system is to treat fatty and oily water produced from the processing area.
- The effluent must be prescreened prior to feed to the system via a 3mm perforated sheet, 1mm wedge wire or 2mm square woven mesh.
- The feed to the Ultraspin system is usually taken when the fluid is hot - ideally upstream of high shear pumps.
- The feed is often taken after a 3 mm effluent screen (rotating screen, wedge wire or similar).
- Systems often make use of floating skimmers. This prevents oil and fat layers in pits and sumps as well as reducing bacterial action.
- Separated fats and oils are:
  - Collected in a waste oil tank with a water decant line
  - Thickened via a small second system

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*Dairy effluent water installation in New Zealand*

*Salty whey fat recovery*

*Whey fat recovery*

*Caustic wash water recycle treatment, Warrnambool, Australia*
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TYPICAL DAIRY EFFLUENT WASTE WATER SYSTEM

COARSE SCREENING
- PERFORATED SHEET
- 3mm OR ADJACENT
- 2mm OR ADJACENT WASH
- NOTE: WASH MESH SCREENING IS THE LAST PREFORMED METHOD

COLLECTION PIT
- RECEIVING PENDANT
- ULTRASPIN BOWL
- ACTS AS BALLANCE
- SLURRY

PRIMARY ULTRASPIN SEPARATION
- ULTRASPIN Fat/Oil Separation
- ULTRASPIN Optional Heavy Solids Separation

FAT THICKENING
- FLOWS: 2000-5000GPD RECEIVED
- FLOWS: 200-400GPD OIL THICKENING SEPARATION
- COLLECTED OIL
- TREATED WATER

TREATED WATER
- StREAS M
- SOLIDS
Ultraspin is an experienced supplier to the dairy industry. The following table lists some of our projects.

### Average Load Reductions Summary

<table>
<thead>
<tr>
<th>Location</th>
<th>Products</th>
<th>Delivery</th>
<th>O&amp;G (%)</th>
<th>SS (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Queensland</td>
<td>Milk</td>
<td>July-03</td>
<td>75</td>
<td>70</td>
</tr>
<tr>
<td>NSW</td>
<td>Cheese</td>
<td>May-03</td>
<td>80</td>
<td>70</td>
</tr>
<tr>
<td>Victoria</td>
<td>Cheese Powder</td>
<td>Mar-01</td>
<td>85</td>
<td>NA</td>
</tr>
<tr>
<td>TeRapa</td>
<td>Butter Cheese Powder</td>
<td>Feb-00</td>
<td>80</td>
<td>NA</td>
</tr>
<tr>
<td>South Australia</td>
<td>Cheese</td>
<td>Jun-99</td>
<td>70</td>
<td>55</td>
</tr>
<tr>
<td>Victoria</td>
<td>Cheese</td>
<td>Jan-98</td>
<td>88</td>
<td>71</td>
</tr>
<tr>
<td>Victoria</td>
<td>Butter Cheese Powder</td>
<td>Oct-96</td>
<td>93</td>
<td>NA</td>
</tr>
<tr>
<td>Queensland</td>
<td>Cheese Powder AMF</td>
<td>-</td>
<td>85</td>
<td>70</td>
</tr>
<tr>
<td>South Australia</td>
<td>Cheese Town Milk</td>
<td>-</td>
<td>77</td>
<td>60</td>
</tr>
<tr>
<td>South Australia</td>
<td>Town Milk</td>
<td>-</td>
<td>50</td>
<td>25</td>
</tr>
</tbody>
</table>

Typical test results. From left to right: Treated, Separated Fat Stream, Inlet
HELPING UNICORN CHEESE REMOVE FAT FROM THEIR EFFLUENT

FAT REMOVAL AND COLLECTION
TREATMENT PLANT

Unicorn Cheese, with the approval of Shoalhaven Council, installed an Ultraspin separation system to bring their effluent discharge down to an acceptable standard for discharge to sewer.

Ultraspin supplied a 20m³ balance tank for fat skimming and pH correction, a 15m³/h separator set to remove fat and a heated fat tank to further separate and store neat fat. Ultraspin’s scope of supply also consisted of a wedge-wire screen mounted on an access platform, all connecting pipework, electrical control box for pump and heaters, installation and commissioning.

The Ultraspin separator reduced the fat in the effluent by 80% and suspended solids by 70%. This has significantly reduced their waste disposal charges.

Above: Close-up picture of ES15 separator system. Four horizontal separators can be seen on manifolded system.

Above: Top picture shows a close up of the separated fat and oil outlet manifold. The picture just below it shows the self adjusting skimmer weir ring.

Left: Overview of the Ultraspin separator system showing the wedge wire screen (elevated on the left) the balance tank (left below screen), the debris collection bin (below screen) and on the left side the separated fat and oil collection and decant tank.
HELPING NATIONAL FOODS, CRESTMEAD, REMOVE FAT FROM EFFLUENT

FAT REMOVAL AND COLLECTION TREATMENT PLANT

National Foods, Crestmead, which is a town milk packaging plant, installed an Ultraspin separation system to bring their effluent discharge down to an acceptable standard and reduce trade waste charges.

Ultraspin used an existing balance tank for fat skimming and pH correction, a 25m³/h separator set to remove fat and a heated fat tank to further separate and store neat fat. Ultraspin’s scope of supply also consisted of an electrical control box for pump and heaters and commissioning.

The Ultraspin separator reduced the fat in the effluent by 80% and suspended solids by 70%. This has significantly reduced their waste disposal charges with the potential to sell the recovered neat fat.
Close-up of control box, pump set and ES25 separation vessel.

The result: both photos show the collected fat inside the decant tank. Top photo shows fat about to spill over the weir plate into the neat-fat-collection compartment.
Typical Scope of Work

Ultraspin Scope of Supply

1.0 Ultraspin Separator Set
- Ultraspin Separator vessel (larger flows), stainless steel vessel M28 model separators.
- Coarse feed strainer with 3mm debris collection, with debris strainer basket
- Pressure indication alarm
- Isolation valve, local instrumentation etc.
- Automatic back-flush system

2.0 Pump Set
Feed pump typically 450 kPa discharge
- Very low flow systems – air operated diaphragm pump
- Medium flows – helical rotor pumps
- Higher flows – low shear centrifugal pumps

3.0 Skimmer Set
- Ultraspin S2 floating skimmer(s) for hot and cold wells
- Stainless steel construction with knuckle joint suction pivot
- 6 metres of 2½” suction hose

Ultraspin Options
- Fat handling systems
- Commissioning and operator training
- Additional skimmers for other wells
- Spare parts for 12 months operation

Typically Not Included
- Site installation
- Materials required for site installation
- Local, State, Government, Authority approvals