Snapshot Report

AMPC
AUSTRALIAN MEAT PROCESSOR CORPORATION

Megasonics for FOG Recovery in Wastewater

Megasonics for Separation and Recovery of Fat Oil and Grease from Abattoir Wastewater Streams: A Proof-of-Concept Study

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Project Description

Red meat abattoirs generate large amounts of wastewater containing fats, oils, and grease (FOG). Traditionally and the most common technologies such as dissolved air floatation (DAF) and decanters (tricanters) are used to recover FOG for tallow manufacture and/or for treatment of wastewater. Depending on the efficiency of these technologies and equipment under different operating conditions, FOG may not be completely separated and recovered but escape as emulsions and be lost, leading to losses in tallow production and poor-quality wastewater. This can cause downstream problems with crusting and reduced efficiency in aerobic/anaerobic digestion ponds and high bacterial loads.

The aim of this project was to carryout laboratory-scale proof-of-concept trials using for the first time, a novel CSIRO patented high-frequency megasonics (MS) technology, to investigate its efficacy in enhancing the separation and recovery on FOG, through demulsification of emulsions. Four abattoirs participated across Australia in this project, two in Queensland (Q1 and Q2) and two in Victoria (V1 and V2). This aim of trialling MS was based on the success of this technology to separate and recover palm oil from emulsions in palm oil mill effluent.

Project Content

1. The four participating abattoirs were surveyed by questionnaire, site visits (for three) and interviews to understand wastewater treatment process flows and the greatest issues with respect to FOG loss, for scoping of the project and identifying the most relevant intervention points.
2. A literature and patent review was carried out to better understand the key technologies being developed and which are commonly used in the industry to separate and capture FOG and treat wastewater, and to see if MS had previously been used for FOG separtions in the meat processing industry.
3. Bench-scale MS trials were conducted on the DAF wastewater streams for the two Queensland abattoirs and from the DAF sludge and decanter tallow sludge streams from one Victorian abattoir to assess the efficacy of MS treatments. The other Victorian abattoir (V1) was unsuitable for trials as it didn't use a DAF or decanter, as its tallow rendering was done offsite and there were no issues with FOG in the downstream wastewater.

Project Outcome

1. MS was not applicable for FOG recovery from DAF wastewater from Q1 and Q2 due to the FOG content being too low. Preliminary trials showed that MS treatment had no effect due to this very low FOG content.
2. For V2 megasonic treatment of the FOG-rich DAF sludge after cationic polymer coagulant-flocculant ((Core Shell ® 71301) addition, and the secondary decanter tallow sludge (DTS) was found to be ineffective on its own, and did not separate the FOG. However, centrifugation at a laboratory scale with or without prior MS treatment was able to partially break the emulsions and separate FOG, hence centrifugation is much more effective.
3. MS with centrifugation of DTS showed improved but variable separation of FOG compared with non-MS treated samples depending on centrifugation conditions (see table below). At high and low centrifugal force the separation of FOG between MS and non-MS treated samples was comparable and therefore did not justify the use of a preliminary MS treatment. At a narrow optimum centrifugal force and treatment time and preliminary MS treatment obtained significantly higher FOG separation compared to non-MS treated sample (91% vs 48%, respectively).

Effect of MS treatment followed by different centrifugation conditions on % FOG separation from decanter tallow sludge (DTS) in V2

Centrifugation conditions	% FOG separation with MS	% FOG separation without MS	% improvement due to MS treatment
1717g, 3min	91	48	43
671g, 5min	67	56	11
2683g, 1min	72	68	4
2683g, 2min	62	56	6

MS treatment at 600kHz, 20min at 50°C

4. For V2 The FOG from the DAF sludge and DTS was not suitable for tallow production due to contamination from the green stream, although if recovered could be used as a feedstock for biodiesel production.
5. Three other streams were investigated which were prior to mixing with the green stream and entry to the DAF:
    a. The PP3 black pit was almost exclusively FOG, which was dark red in colour and separated from the water at 50 °C upon standing without MS treatment or centrifugation and represented a major source of FOG lost to the DAF and ultimately in the DTS.
    b. The two other streams: pre-PP3 (rendering plant centrifuge wastewater) and PP2 (rendering plant stickwater) consisted of a whitish high-quality FOG emulsion which did not separate after MS treatment alone but only after centrifugation with no difference between MS and non-MS treatments showing that centrifugation alone can be used to effectively capture the FOG. These two streams are considered major contributors to lost FOG in the downstream wastewater.
6. Surprisingly, heating the pre-PP3 emulsion sample followed by cooling to room temperature alone was effective in flocculating the FOG and floating it to the surface without needing aeration, clarifying >50% of the water making this technique amenable to DAF for recapture of FOG for recycling back into the render cooker for increased tallow production and reduced FOG load to the DAF and decanter.

Benefit for Industry

Improved DAF performance for Q1 and Q2

MS treatments were not affective for DAF wastewater in Q1 and Q2, however improvements in the efficiency of the DAF can be achieved by reducing operating temperatures to below the melting point of FOG and to maximum solubility of air and minimum bubble size.

FOG for biodiesel feedstock for V2

MS treatments were ineffective on their own without centrifugation, in separating FOG from the DAF sludge or decanter tallow sludge. Although better separation of FOG could be accomplished effectively from either stream using a secondary centrifugation step, the low-grade FOG would only be fit as a biodiesel feedstock. Sales of this useful biproduct could generate revenue to offset wastewater treatment costs and reduce sludge disposal and offsite treatment costs. A better option though, would be to use the PP3 black pit stream as this is very high in FOG, is not contaminated by the green steam and readily separates without centrifugation.

Increased tallow manufacture

The pre-DAF streams (PP2 and PP3 from the rendering plant) could be recovered easily and efficiently by either a secondary centrifugation or a primary DAF with cooling but without the addition on any chemical coagulants/flocculants for recovery of high-grade FOG for increased high quality tallow production. It is uncertain if the FOG from the PP3 black pit would be suitable for tallow manufacture due to the reddish colour if this would be eliminated in the render cooker. This could be explored in a future project.

Capturing as much as possible of the high quality FOG as early as possible from the wastewater emerging from the rendering process (PP2 and pre-PP3) will, in addition to increasing the yield of high-grade tallow, reduce the load of FOG in the DAF and decanter, and hence improve water quality and reduce environmental impact. It will also reduce cost associated with disposal and off-site treatment of the decanter tallow sludge.

Further investigation of the possibilities around the PP3 black pit, pre-PP3 and PP2 streams is advisable for this and other abattoirs which are implementing similar wastewater treatment technologies and protocols, and may be encountering similar FOG loss challenges.