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Food
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Practice Note

Sustainable practices for microbreweries

School of Chemical Engineering & Advanced Materials,
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Microbreweries operate on a small scale but the production process can be very demanding in terms of energy, water and waste product. This briefing summarises the outcomes of Stu Brew's research into sustainable brewing practices. The research has implications for microbreweries in helping them to reduce their ecological footprint by reducing grain and yeast wastes and optimising cleaning. Stu Brew encourages the North East community to come together, share examples of best practice, and do our bit to help reduce the footprint of the craft beer industry. By sharing ideas that shape our future research activities, we can investigate the issues most important to you -- the North East Brewing Network.

Mashing in at Stu Brew's microbrewery, Newcastle University.

Key statistics about the North East Brewing Sector

- Between 40-50 Breweries in Tyneside & Northumberland (CAMRA website).
- Approximately 3.6 Million Litres of beer produced per year (10 BBL/week average assumed).
- 21.3 Million litres of water used in the production process (SWC figure of 5.91 L Water / L basis).
- Assuming 0.4kW/L based on Stu Brew energy consumption for October 2016 this would require 1.8 Gigawatts of electricity to produce. That's about the equivalent energy generated by 720 wind turbines.
- On a 5% ABV basis that would equate to 675 tonnes of spent grain waste per year, approximately 72 tonnes of yeast waste and about 27,000 L of cleaning chemicals.

What did the project seek to achieve?

- Organise a network of North East Microbreweries with an interest in collaborating to improving the sustainability of their processes (see Figure 1).
- Investigate alternative routes for brewery waste product disposal or reuse.
- Look into low-cost solutions for energy and water monitoring with an aim to reducing resource use.
- Optimisation of standard operating procedures to minimise waste.

Survey of interest in the research project from North East breweries

Level of concern regarding the Sustainability of their brewery?	**Main reasons for concern?**
1. 50% Very concerned	1. Cost
2. 50% Slightly concerned	2. Environmental impact
	3. Image
Most interested in Improving	**Obstacles to improving sustainability?**
1. Energy	1. Space
2. Yeast	2. Funds
3. Hop	3. Manpower
4. Water	4. Know how
5. Transport	
6. Grain	

Figure 1: The number of respondents only accounts for about 7% of the network, but gives an indication of breweries' interest in the research.

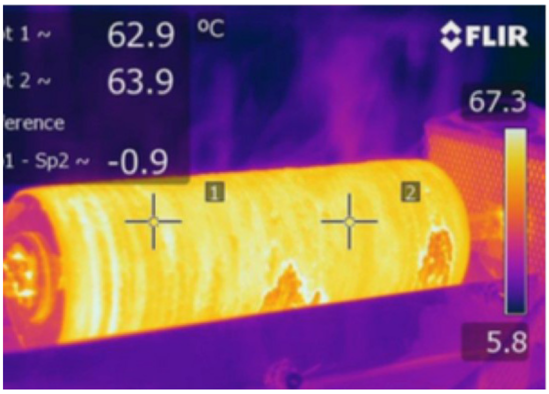

Figure 2: Infra-red image of drum drier.

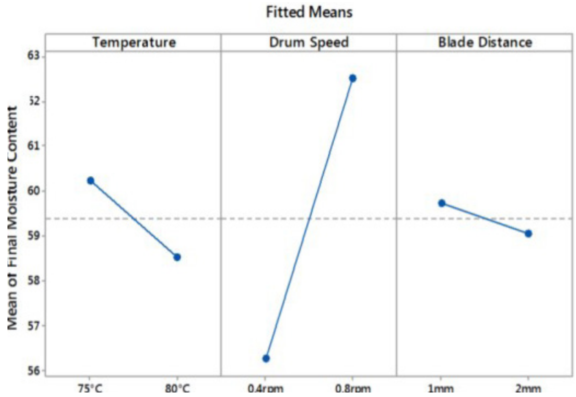

Figure 3: Results of drum design.

Preventing disposal of Spent Brewer's Yeast (SBY)

Why is it important?

If disposed-of down the drain Spent Brewer's Yeast adds substantially to the Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Suspended Solids (SS) of the effluent stream, putting pressure on wastewater treatment that requires more energy to clean water and generates more greenhouse gases.

What can be done about it?

- Yeast can be used as an animal feed, but must be heated to over 60°C in order to inactivate the cells thus allowing it to be fed to livestock.
- A novel rotary drum drier designed at Newcastle University was found to produce optimum conditions for yeast drying. The surface temp of the yeast was sufficient for inactivation of the cells (see Figure 2).

Energy generation from Spent Brewer's Grain (SBG)

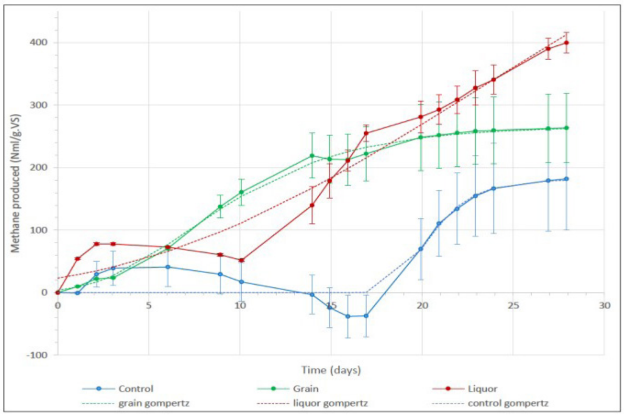

Figure 4: Methane produced by anaerobic digestion.

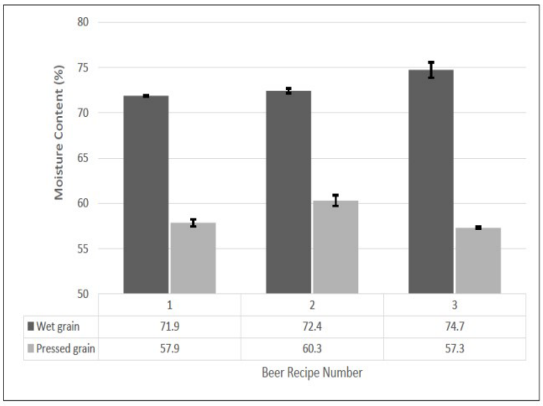

Figure 5: Moisture content of spent grain and pressed spent grain for various recipes.

Why is it important?

Spent Brewer's Grain (SBG) can be used to generate energy from anaerobic digestion (AD) with high conversion to biogas. The research looked into energy generation from SBG in order to investigate alternative methods of disposal other than the traditional route via the livestock food chain (Figure 4). The dried SBG was then tested as a potential fuel source for a biomass boiler, whilst the recovered pressing liquor was evaluated for Anaerobic Digestion (AD).

What did we find out?

- Low-cost mechanical methods of pressing, followed by a passive drying system, can be used to increase the SBG lifetime and reduce transportation costs (Figure 5).
- The methods of grain drying and briquetting used were not capable of reducing the moisture or providing sufficient binding of the material to use as a solid fuel source.
- The spent grain pressing liquor is an attractive AD substrate, with high conversion to methane, although the quantities recovered on 2BBL scale were limited. However, this is not the only source of unused wort in the process and "last runnings" may provide a useful supplement for AD.
- Research into alternative methods would be possible, but would not be economically attractive to the network whilst the current disposal method is available.

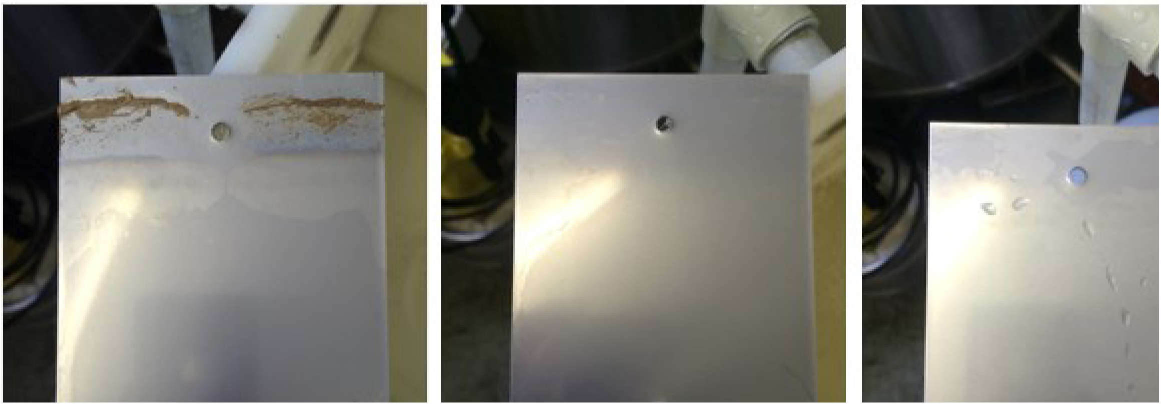

Figure 6: Stainless Steel samples after various phase of cleaning (a) after pre-rinse cycle (b) after caustic cycle (c) after post rinse & sanitisation.

Additional findings

Three step sustainable cleaning method for brewery equipment:

1. Slightly increase the duration of a pre-rinse step in the temperature range of 30-50°C, with “high” flow-rate.
2. Use 0.5% solution of caustic detergent.
3. Follow up with two rinses.

Chemical usage can be reduced without compromising tank sterility

Stu Brew could provide access to this testing equipment for other members of the network to benchmark cleanliness (Figure 7) across the NE brewing sector.

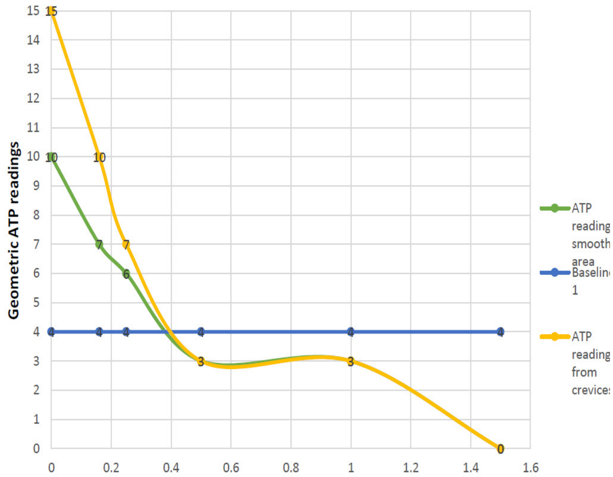

Figure 7: ATP swab readings vs caustic concentration. ATP (life) swab readings are used to determine cleanliness of brewery equipment. Any readings below 10 (left axis) is considered clean.

Monitoring waste and energy usage

This project focused on quantifying outputs and utility usage in the brewery. Through the installation of energy and water meters the brewery utility usage profile could be established as shown in Figure 8. This enabled energy and water usage calculations to be performed and best practice to be identified through observing staff behaviour in the brewery.

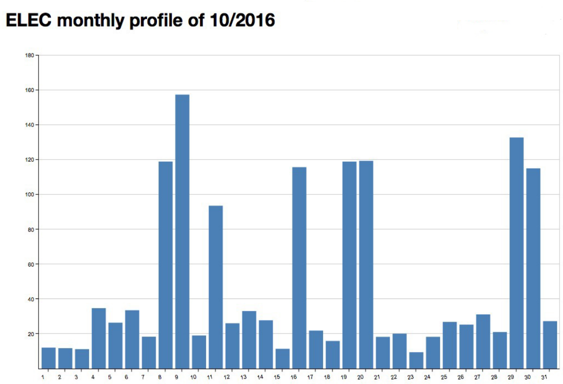

Figure 8: Stu Brew Energy Meter Readings for October 2016 (kW vs day of month).