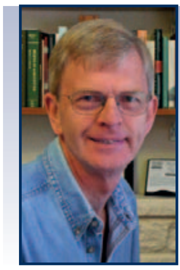
Managing FOG



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Fat, oil and grease (FOG) should never be poured down drains because they can form deposits that restrict flow through and even block sewers. But recent research shows it's not as simple as we used to think.

Sewerage undertakers estimate it costs in the region of £15-20 million per year to deal with FOG in the UK's public sewerage (that was before the transfer of private sewers on 1st October 2011). The estimate is uncertain because the quality of reporting the causes of sewer impedances is poor. The cost is made up of blockage removal, sewer/pumping station cleaning etc. and, sometimes, sewer flooding incidents (clean-up of property and compensation) and associated pollution events (clean-up, fines etc). Domestic customers, commercial customers and insurance companies incur similar cost in dealing with FOG in private systems. Perhaps double if the loss of business and inconvenience to the premises' owner were included.

There are many sources of FOG but one of the largest is food service establishments, FSEs (restaurants, takeaways, hotels, schools, etc.). The problems often appear greatest where sewerage serves several FSEs, such as in some town centres. A proportion of FOG also comes from domestic users; ethno-socio-economic factors play a part in how much FOG is discharged.

Mining FOG from beneath Leicester Square, London. photo PA

FOG can deposit inside sewage pumps, where it can restrict the cooling (which is by sewage flowing around the jacket) and cause pumps to overheat and trip out. When a sewer blocks or sewage pumping station stops, the sewage backs up and somewhere floods. Combined sewer overflows (CSO) are designed as safety valves so that excess flow is diverted to somewhere less damaging than people's homes, etc. but "unplanned" flow restrictions can result in "unplanned" overflows.

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There are two types of FOG blockage:

- fat that was poured down a drain at a temperature above its melting point and then solidifies when it cools. This happens close to the premises that poured it down the drain
- chemically reacted FOG, it is hard and needs to be dug out; it has been called FOGc by the UK's FOG Forum, hosted by British Water.

Sometimes, FOG and FOGc have been associated erroneously with under-sink food waste disposers (FWD) but the evidence refutes this proposition. Field studies into the effects of FWD that have been published have found, by CCTV and/or flushing, no change in sewer deposits before and after FWD installation. The Westminster City Council does not permit FSEs to have FWD discharging to sewers and yet the FOGc in the sewers under Leicester Square (in Westminster CC) is notorious; evidently, not having FWD does not guarantee no FOGc.

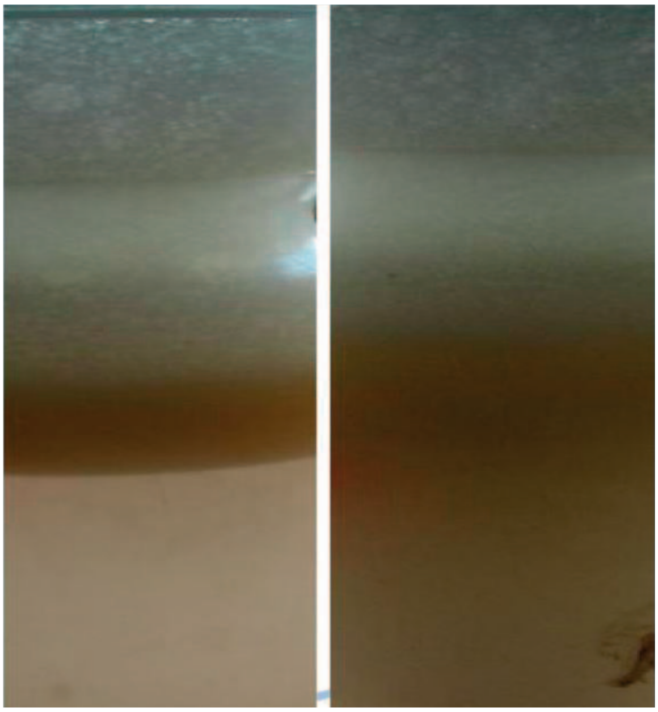
A Water Environment Research Foundation (WERF) study of FOG examined samples from all around the USA. It is the largest study of FOG to date. It found that FOG was predominantly saturated fatty acid (mainly palmitic) irrespective of whether the cuisine locally was dominated by saturated or unsaturated fats and oils. FOG samples collected in the UK by Southampton University were also predominantly saturated fatty acid. WERF found fatty acids had reacted with metal ions, mainly calcium, in a saponification reaction to form insoluble soap (calcium palmate). The WERF researchers say they did not see (by microscope examination) evidence of FWD output in FOGc samples.

The best hypothesis for FOGc formation (priv. comm. Prof. Kevin Keener, Purdue University, 2010) is that fat, oil and grease are hydrolysed [split into two parts by the addition of a molecule of water (H_2O) so that one part gains a hydrogen ion (H+) and the other the hydroxyl ion (OH–)] into free soluble fatty acids. Hydrolysis can be chemical (e.g. alkaline detergents, degreasers, and sanitisers plus heat) or biological (e.g. acid forming bacteria). In the sewer, these free fatty acids react with metal ions to form insoluble soaps (mainly calcium though Keener found that a trace of iron is required as well). FOGc deposits on surface roughness, roots, rags, protruding gaskets, or some other irregularity in the sewer wall and then the accumulation grows. This explains the apparent selection for saturated fatty acids.

These findings also point to the reason that biological dosing can be effective. Good providers of dosing design microbial combinations (not enzymes) that colonise and maintain sewer biofilms with aerobic organisms that degrade FOG to CO_2 and H_2O. This would also help to prevent hydrolysis to free fatty acids. Chemical composition and temperature fluctuations must challenge biofilm integrity which would explain a need to inoculate and refresh them repeatedly. Biofilms can be very powerful for treating the wastewater flowing through sewers.

The sewerage agencies that seek actively to prevent FOGc by control at source have, through experience, developed a preference for mechanical grease traps (skimmers, etc.) rather than passive ones. In the light of the WERF findings, perhaps passive grease traps can be, in effect, hydrolysis reactors that release soluble free fatty acids to the sewage.

Martin Fairley, Research Director at ACO Technologies plc has turned upside-down some of the conventional thinking about grease traps during his PhD studies at Cranfield University. Conventional thinking has been that the performance of grease traps is impaired by hot water discharges, but Fairley showed that when oil is shaken with water and then left to stand, the oil separates more rapidly in hotter water than in cold. He hypothesised that the rate of collision of small oil globules increases as temperature increases because of Brownian motion and the viscosity of water decreases with increasing temperature.



Comparison of the separation of oil shaken with water and detergent after standing for 5 minutes in 17-19 ° C (right) the 75 - 85 °C (left)

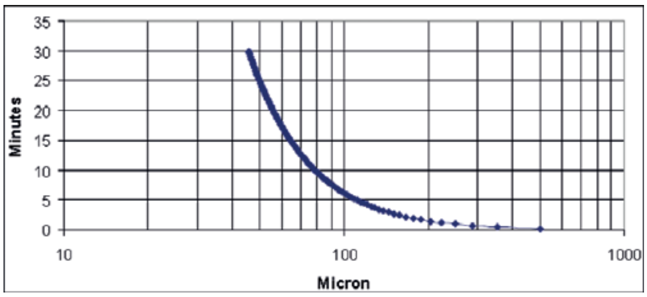
Fairley also calculated the rise time for oil globules and water and how long it would take different size globules to rise 100 mm. Globules of oil with a specific gravity of 0.95 would take more than 6 minutes to rise 100 mm. Of course if they coalesce into larger globules, the rise time would decrease. Fairley found that many globules in wastewater exiting a grease trap were <100 µm.

BlackGold Biodiesel's brown-grease to biodiesel plant at Oceanside WwTW, San Francisco (anaerobic digesters in the background)

Ofwat gave insufficient priority to maintenance for several AMP (asset management plan) rounds (five year programmes) of the UK water industry and more recently corrected this somewhat but there is still much less maintenance and renewal of sewerage in the UK than in many other countries.

Priorities for preventing sewer blockages and restrictions by FOG are:

- Educating FSE operators (and domestic cooks as well) that molten fat is not liquid waste and should not go down drains
- Designing better means of intercepting and removing FOG at source by means that do not allow it to become hydrolysed to soluble free fatty acids
- Providing facilities for converting FOG to biogas, biodiesel and fuel oil.



Relationship of the time for oil globules (specific gravity 0.95) of different size to rise 100 mm in water

For further information visit www.fwr.org and www.timevansenvironment.com or

contact fwr@timevansenvironment.com