School of Construction
Management and Engineering

University of Reading

APPROVING THE QUALITY OF RECYCLED GREYWATER; UNDERSTANDING BS8525 PART 2

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INTRODUCTION

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- Water efficiency is markedly improved by treating domestic greywater from hand basins, baths and showers, so that it is of suitable quality and composition for appropriate reuse;
- Treating greywater locally means that the plant can be specified to meet the local quality requirements, giving confidence to users;
- We need to make information accessible: eg “the clarity is very good at 1.0 Nephelometric Turbidity Units, NTU”, also explaining how the turbidity is measured and what the unit means;
- The greywater quality standard in BS8525 can be widely applied, together with some of its design principles.

SOCIAL ACCEPTANCE OF GREYWATER

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- Social perceptions are a critical influencing factor regarding the acceptability or non-acceptability of risks associated with the use of a greywater;
- Social perceptions of greywater reliability can influence the rate of take-up of greywater technology;
- In order for technology to be widely implemented, evidence must be publicly available to demonstrate risk avoidance and acceptable quality results for treated greywater;
- A desirable outcome is that take-up should increase as public confidence in the reliability of these technologies grows;

RISK REDUCTION AND AVOIDANCE

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Sound design, and careful construction and maintenance are essential in order to achieve risk reduction and avoidance, including;

1) risks to users of mains water arising from potential cross-contamination of mains systems through misconnection or other errors;
2) risks to users of greywater from contamination that could arise from the greywater itself, which might occur if the greywater were not treated appropriately prior to use;
3) other risks to users of greywater described in the literature, for example avoidance of pathogenic aerosols.

DEMONSTRATING RISK AVOIDANCE AND CONTROL

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- Delivering safe systems is a day-to-day task for greywater plant designers, manufacturers and installers; safe systems rely on conducting routine/daily/weekly checks and tests on quality of treated greywater;
- The evaluation of performance to a standard relies on a consistent daily composition of the raw feed (input) so that daily results in treated greywater can be compared;
- So, “recipe” constituents are mixed in standard proportions, and these give a typical analytical profile, see Table 1;
- Anyone wishing to test their greywater quality can use this standard approach, even if their plant is not being evaluated to BS8525.

AIMS OF THE BS8525 GREYWATER STUDY TESTS

The tests aimed to address the matter of uncertainty by:

- 1) defining the performance of greywater treatment technologies with reference to water quality measurements of the untreated and treated greywaters;
- 2) choosing appropriate parameters for greywater monitoring encourages greater diffusion of monitoring equipment, for frequent checks on process efficiency in greywater systems.

The research at the University of Reading builds upon earlier research work on technologies, measurement techniques and monitoring for risk reduction in greywater supplies.

"...BUT BS8525 IS COMPLICATED ..."

British Standard design involves delivering standard greywater, as in BS 8525-2:2011 [2], to a treatment system, having 3 tanks:

- A pre-mixing tank to prepare the synthetic greywater;
- The treatment tank (600litres, Tank 1) provides oxygen diffusion, aerobic microbiological digestion and nanofiltration combined in a single tank MBR (membrane bioreactor);
- The second tank, (600litres, Tank 2) stores the treated water from Tank 1 ready for reuse.
- The quality of the greywater must be measured both before and after the process, so the reduction in the levels of pollutants in the greywater can be demonstrated and verified.

MAKING UP RAW GREYWATER TO BS8525 PART 2

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Parameter	Acceptable range	Test method
E. coli (cfu/100 mL)	10^5–10^6	BS EN ISO 9308-3
COD (mg/L)	180 ±40	BS 6068-2.34
BOD (mg/L)	110 ±40	BS EN 1899-1
NO_3 nitrogen (mg/L)	7.2 ±0.8	BS EN ISO 13395 or BS EN ISO 10304-1
pH	7.0–8.0	BS 1427
Temperature (°C)	30 ±2.5	—

Table 1: Composition of made-up, laboratory synthetic greywater when mixed to the BS 8525 Part 2 constituent concentrations [2]. © British Standards Institution (BSI – www.bsigroup.com). Extract reproduced with permission. Source: BS 8525-2:2011. Greywater systems. Domestic greywater treatment equipment. Requirements and test methods.

BS8525 TEST CONDITIONS

In order to test that a greywater plant can meet BS8525 we require:

1. The choice of one of two different designs for the test:
   - gravity flow, or
   - pumped flow;
2. The test flow conditions to be specified, as a specific flow must be demonstrated;
3. The greywater to be made up at a temperature of 30deg C;
4. The treated greywater quality should be able to be stored for [20 days]* after treatment without quality deterioration; uses laboratory containers.

*BS requires 30 days but, 20 days may be acceptable in many set-ups.

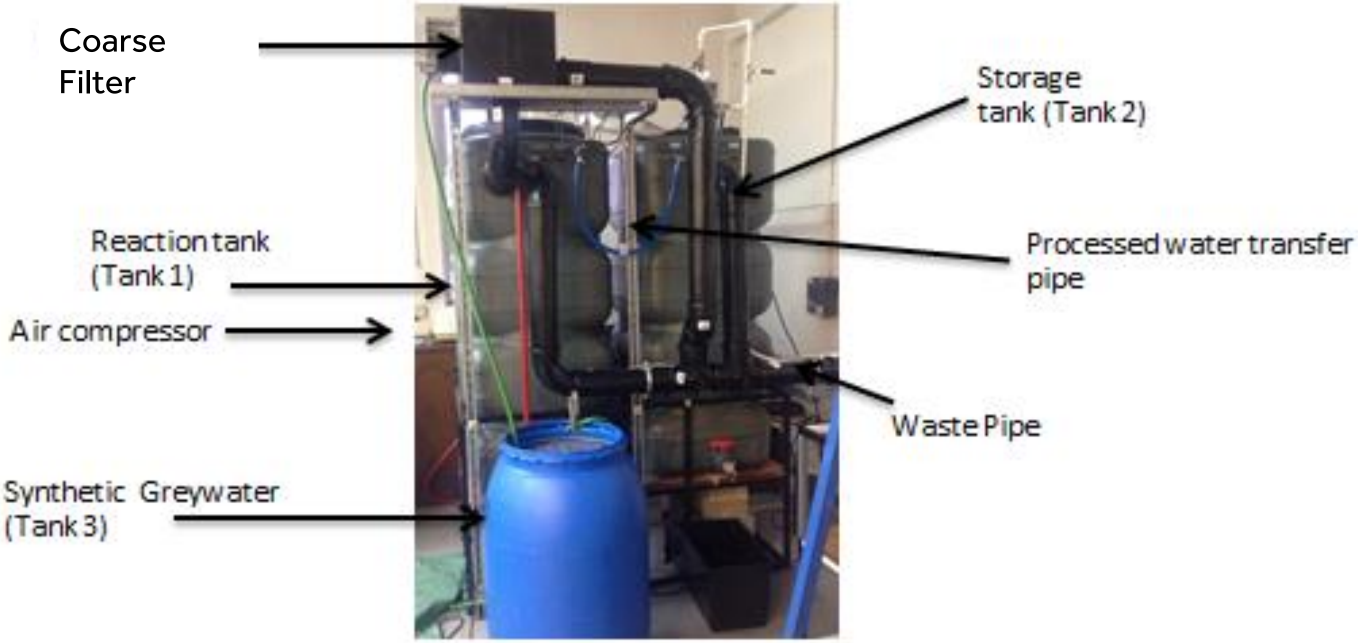

Fig.1 Greywater Treatment Plant at University of Reading, Engineering Building

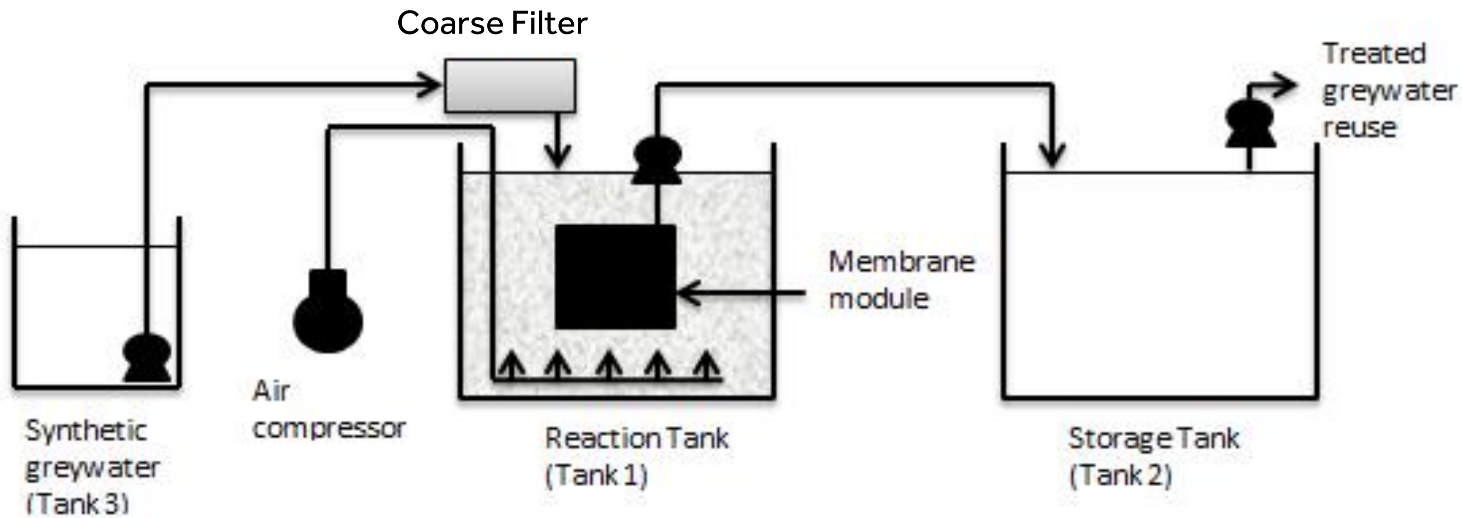

Fig 2. Schematic Diagram of Greywater Treatment Process at University of Reading

STANDARDS FOR TREATED GREYWATER QUALITY, BS8525-2

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Parameter	Spray applications	Non-spray applications			Testing
	Pressure washing, garden sprinkler use and car washing	WC flushing	Garden watering	Washing machine use	
Turbidity NTU	<10	<10	N/A	<10	BS EN ISO 7027
pH	5–9.5	5–9.5	5–9.5	5–9.5	BS 1427
Residual chlorine [A)] mg/L	<2.0	<2.0	<0.5	<2.0	BS EN ISO 7393-2
Residual bromine [A)] mg/L	0.0	<5.0	0.0	<5.0	Blue Book 218, Method E10 [N1]

[A)] Where chlorine or bromine is used in the treatment process.

Table 2: Chemical and physical quality requirements for treated greywater for type test [2] © British Standards Institution (BSI – www.bsigroup.com). Extract reproduced with permission. Source: BS 8525-2:2011. Greywater systems. Domestic greywater treatment equipment. Requirements and test methods.

REQUIREMENTS OF BS8525 PART 2

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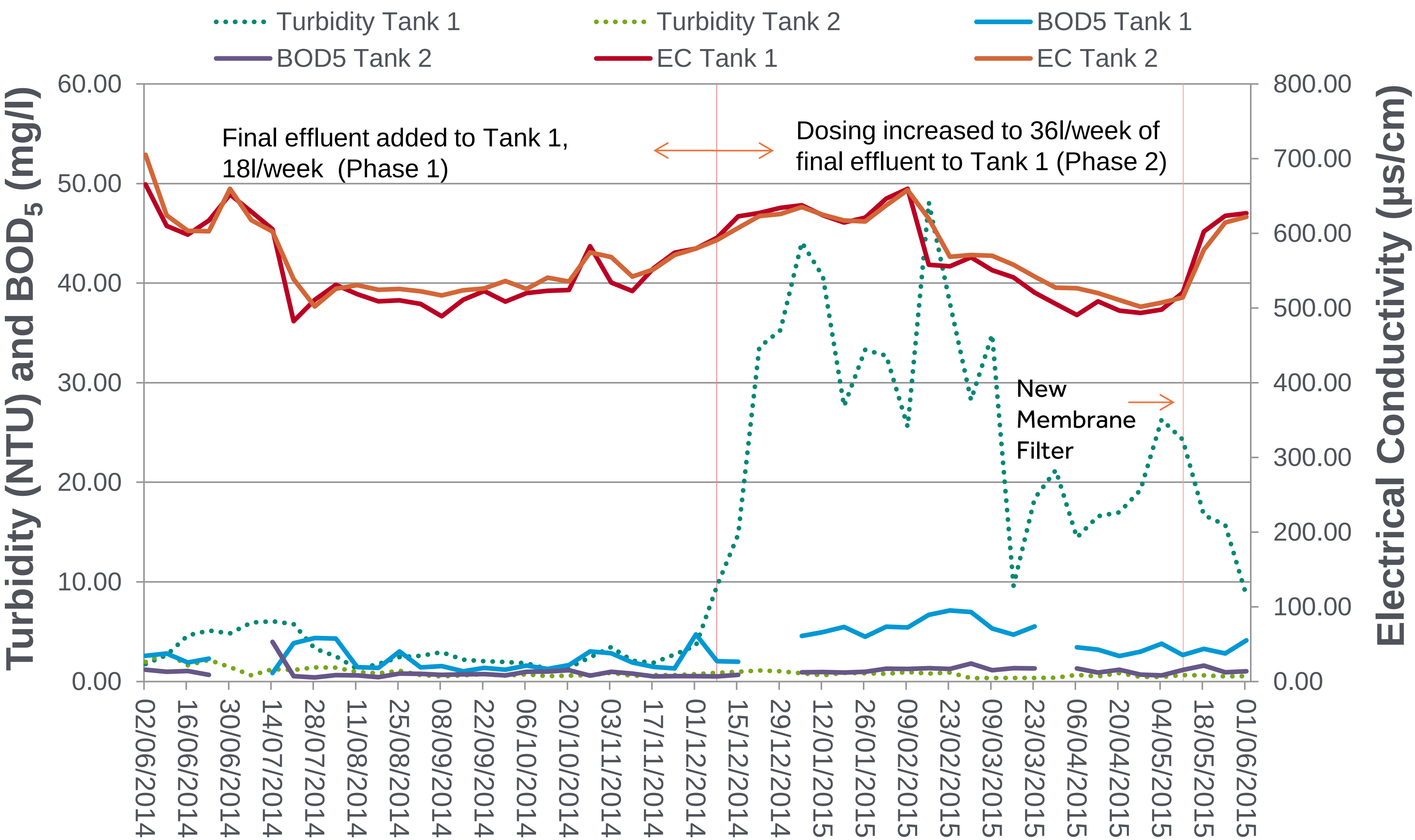
Parameter	Spray applications	Non-spray applications			Testing	
	Pressure washing, garden sprinkler use and car washing	WC flushing	Garden watering	Washing machine use	Spray applications	Non-spray applications
E. coli number/ 100 mL	Not detected	25	25	Not detected	BS EN ISO 9308-1	BS EN ISO 9308-3
Intestinal enterococci number/ 100 mL	Not detected	10	10	Not detected	BS EN ISO 7899-2 or BS EN ISO 7899-1	BS EN ISO 7899-1

Table 3: Microbiological quality requirements for treated greywater for type tests [2] © British Standards Institution (BSI – www.bsigroup.com). Extract reproduced with permission. Source: BS 8525-2:2011. Greywater systems. Domestic greywater treatment equipment. Requirements and test methods.

CONSIDERATION OF THE ROLE OF THE TURBIDITY STANDARD

- Recent analytical results have demonstrated the efficiency of the combined MBR and nanofiltration process;
- The process has achieved approximately 100% efficiency in reducing turbidity;
- The importance of specifying the measurement and monitoring of turbidity has been confirmed for greywater quality, as described and specified in BS8525 Part 2.

ASSESSING THE COMPLIANCE OF RESULTS



BENEFITS OF PERFORMANCE TESTING USING SYNTHETIC G/W

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- Testing using synthetic greywater permits comparability over time; changes and performance of the plant and between different plants can be easily compared by the manufacturer;
- Testing using synthetic greywater allows diagnoses of problematic conditions, should they arise;
- If the plant can produce a consistent stream of treated greywater, this suggests it would be likely to successfully progress to certification if so required;
- Use a statement of “compliance to a consistent quality standard”.

BENEFITS OF APPLYING BS8525 PART 2 TO ROUTINE WORK

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- Risk reduction and risk avoidance; using sound design, careful installation and maintenance procedures;
- Requirement for greywater equipment manufacturers, installers and users to make regular checks, and to test the quality of the treated greywater;
- Increased user confidence, as well as confidence in the market for greywater equipment, measurement devices, components and consumables;
- New thinking about the value of making routine turbidity measurements.

ANY PROBLEMS IN APPLYING BS8525?

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- The following is a selection of complaints;

1. Volumes of test liquid required are “too great”;

   -Test could potentially be carried out using reduced volumes whilst still achieving a demonstrable performance;

2. The greywater has to be tested at 30degreesC. This makes the process unnecessarily constraining, due to difficulty in heating the required synthetic volumes to this temp;

   -30degC was chosen in order to reflect the temp of used shower water;

   -A lower temp. could reasonably be proposed, such as 20degC.

3. How can the required number of bacteria be made up in the synthetic greywater;

   -It is not necessary to count the bacteria each time in the synthetic solution, as long as the approximate range is known; of primary importance is achieving appropriate microbiological quality in treated greywater.

CONCLUSIONS

- The take-up and diffusion of greywater technology protects the value of water resources, and contributes to reducing the risks of water scarcity and vulnerability;
- Locally monitored greywater to BS8525 or equivalent quality criteria, ensures that the expectations for safely functioning greywater systems will be met, provided that a number of safety controls are implemented;
- The monitoring of turbidity as one primary measurement parameter for a well-treated greywater, has been shown to be effective, reliable and cost efficient, usually when turbidity is measured in conjunction with other key criteria

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