Fats, Roots, Oils and Grease (FROG) in Centralized and Decentralized Systems

Fats, oils, and grease (FOG) are generated every day by food preparation and cleaning activities at commercial establishments and, on a smaller scale, by residential sewer customers. Analyzing the chemical and physical makeup of FOG deposits in the sewer collection system is a crucial step in determining what compounds should be limited in the effluent discharge of grease interceptors. This report identifies the major chemical constituents and physical characteristics of FOG deposits retrieved from sewer collection systems nationwide.

Maximum level of root occlusion in pilot system.

The invasion of sewer pipes by tree roots presents another common problem and a major cost to utilities and private property owners. When a root encounters sewer pipe conditions (high moisture and nutrients), the root system tends to envelope that section of sewer pipe, particularly when the surrounding soils are poor in nutrients or low in water content. Roots grow by elongation, which allows them to enter small openings in sewer joints and cracks.

Municipalities currently utilize root control practices involving chemical or mechanical methods to curtail the formation of dense mats of root hair in sewer lines. As the mat forms, the slower wastewater flow exacerbates the rate of accumulation and promotes the deposit of FOG materials, further reducing capacity. FOG or root accumulations in the sanitary sewer collection system, if not periodically cleaned, result in reduced capacity that may lead to sanitary sewer overflows (SSO).

The Research Approach

The researchers measured total oil and grease, metals and mineral content of FOG deposits provided by several utilities with collection systems. The research team compiled shear and compressive strength data, and they developed fatty acid profiles. In addition, researchers performed surface chemistry analyses on sewer pipes and tree roots to determine if there is a preferential deposition of FOG on specific surface types.

Based on the analyses, the researchers concluded that FOG deposit formation is similar to the formation of soaps through fat saponification. In the majority of the deposits, unsaturated fatty acids are not a major contributor to FOG blockages. The alkaline conditions in the wastewater from cleaning solutions contributed to this process.

This project resulted in the following products:

- Fats, Roots, Oils, and Grease (FROG) in Centralized and Decentralized Systems (03CTS16T)
- Assessment of Grease Interceptor Performance (03CTS16Ta)
- FOG Interceptor Design and Operation (FOGIDO) Guidance Manual (03CTS16Tb)

BENEFITS

- Characterizes the chemical and physical makeup of FOG deposits in collection systems.
- Determines that FOG deposits are formed primarily by saponification and are metal soaps.
- Determines that different root-type materials have different susceptibility to blockages caused by FOG.
- Identifies root control methods to reduce root intrusions in sewer systems.
- Determines the optimal design, sizing, and operations and maintenance criteria for grease interceptors.
- Develops an alternative design methodology for grease interceptors that can be submitted to the International Association of Plumbing & Mechanical Officials (IAPMO) for consideration for inclusion into the Uniform Plumbing Code.

RELATED PRODUCTS

An Examination of Innovative Methods Used in the Inspection of Wastewater Systems (01CTS7)

Effective Practices for Sanitary Sewer and Collection System Operations and Maintenance Online Tool (01CTS20T)

Minimization of Odors and Corrosion in Collection Systems: Phase I (04CTS1)

Inspection Guidelines for Wastewater Force Mains (04CTS6UR/URa)

Strategic Asset Management (SAM1R06)

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The research team compared two chemical root control methods and a mechanical control method. They tested root control in a pilot-scale sewer system that included three types of trees. They performed surface roughness and polarity measurements of common piping materials, examined different tree root material, and determined the impact of root types on preferential deposition of FOG in the sewer mains.

The researchers also determined the optimal design, sizing, and operations and maintenance criteria for grease interceptors. The team employed experimental and numerical techniques to understand and quantify the performance of grease interceptors. They developed alternative designs using 2-D and 3-D models and tested the designs at the laboratory scale.

Researchers examined different theoretical residence times to quantify FOG removal performance relative to reactor size. They also investigated the effects of temperature and detergents to determine the influence of operational conditions on the FOG removal process. Finally, the team conducted field measurements of grease interceptors to understand the dynamics of FOG separation from food solids in the grease interceptor.

What This Report Offers

As a result of the analysis of grease interceptor performance, the researchers concluded:

- Extending the residence time in a grease interceptor by a factor of 3 only yielded approximately 10% improvement in performance, suggesting that FOG loading is only part of the variables affecting grease interceptor performance.
- FOG droplet size significantly affected FOG removal performance.
- Serious issues result from the use of detergents and/or mixing on the performance of a grease interceptor.
- Inlet/out configurations must be designed to distribute the flow.
- Fluid velocities near the inlet and outlet should not exceed 0.015 m/s.
- Only include baffle walls with specific inlet/outlet configurations.
- Design baffle wall to distribute the flow and minimize the occurrence of high local fluid velocities.
- The standard mid-baffle wall configuration could be used for simple retrofits.

This study clearly identified the major chemical components of FOG deposits.

- FOG deposits are basically metallic soaps. The reaction begins at the restaurant or foodservice establishment discharge. FOG is removed from dishware during cleaning, and interacts with excess cleaners and sanitizers to begin the saponification process. The sanitary sewer system contains wastewater with minerals and naturally present metal ions. Within the sanitary sewer system, the strong oxidizing agents hydrolyze the FOG in the presence of metal ions to produce metallic soaps.
- PVC pipe does not play a major role in FOG accumulations in sanitary sewers. Oil accumulations on tree roots, on the other hand, are an important consideration in FOG deposit prevention strategies.
- Root control experiments revealed that effective root treatment may require some combination of both mechanical and chemical treatments. Once unimpeded flow resumes, chemical treatment alone could suffice.

Applying the Research Findings

Researchers developed a design methodology that can be submitted to the International Association of Plumbing & Mechanical Officials (IAMPO) for consideration for inclusion into the Uniform Plumbing Code. As a result of this research, grease interceptor design can be based on a revised, transparent method for the calculation of flow rate into grease interceptors. A new equation for grease interceptor sizing, taking into consideration expected FOG and solids accumulation, may also result from this research.

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