
ODOR AND GREASE CONTROL IN COLLECTION SYSTEMS; MECHANISM OF ACTION

NEOZYMES™ are effective in controlling odors and grease in lift stations, force mains and by gravity mains by preventing the production of hydrogen sulfide, ammonia and mercaptan and by substantially minimizing existing odors. This is accomplished through four distinct mechanisms:

- 1) Reducing the grease and slime layer that protect the anaerobic bacteria and regulate the transfer of oxygen to these organisms;
- 2) Providing factors for proper aerobic biological activity including catalysts and available oxygen;
- 3) Solubilization of food sources which enhance the aerobic environment; and;
- 4) Enhancement of chemical oxidation, neutralization and complexing of existing odors.

REDUCING THE SLIME LAYER

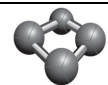
NEOZYMES™ rapidly degrade the slime layer and grease build-up inside collection system pipes and receiving basins. This removes the barrier that protects anaerobic organisms, limiting their activity. This can also lead to the actual physical removal of these organisms from the pipe surfaces altogether as well as reduction of grease and slime to a more soluble food source for aerobic biomass. Although this suggests that NEOZYMES™ may be detrimental to a downstream treatment plant, *the opposite is true*. The catalytic effects of the Neozyme formulations produce superior bio-emulsification, which can lead to increased performance in the downstream treatment plant. The treatment plant biomass does not have to generate as many bio-emulsifiers since the reduced food source arrives at the plant in a more absorbable form. NEOZYMES™ also increase the oxygen transfer within the waste stream making gaseous oxygen available, further inhibiting anaerobic bacteria and promoting aerobic Digestion. There may be a nominal initial increase in BOD at the treatment plant due to this action, but it is slight and exists briefly.

The entire Neozyme cleaning mechanism is dependent on the actual velocities within the pipe, which physically transport the slime and grease away, as well as the effective time within the system. This same mechanical reducing action can also apply to oils and fats that collect on the pipe, receivers and wet wells. Once this *odor-free* action has taken place, a lower dosage of NEOZYMES™ is required to maintain a clean, odor-free system. A clean collection system will shift the reactionary maintenance associated with clogged pipes, pumps and control system to more easily managed scheduled maintenance.

PROVIDING BIOLOGICAL FACTORS

The limiting biological factors for aerobic environments commonly found in force and gravity pipelines are normally oxygen and dissolved food sources. NEOZYMES™ are unique in their ability to cause the formation of microbubbles of gas, high in oxygen, which are so small (not visible to the human eye) that dissolved oxygen meters cannot recognize the difference between the oxygen available in these bubbles and the dissolved oxygen in the waste stream. These micro bubbles provide supplemental available oxygen, so that when dissolved oxygen levels fall, oxygen transfers from microbubbles into dissolved oxygen and is used by microorganisms and/or chemical reactions. In gravity lines, there is sufficient agitation and air circulation to produce this dispersion of gas in bubbles. In closed pipe or force main situations, air, or compressed air is introduced after the pump at the lift station. In a force main, the high discharge pressure and low wastewater temperature will cause it to rapidly go into solution and the microbubbles will actually provide a reserve of available oxygen.

NEOZYMES™ are self-organizing complexes which combine with other organic compounds, bringing together food, oxygen, microorganisms and other reactive chemicals. The bio-emulsifiers of the complex rapidly break down complex food sources less complex compounds that are more readily absorbed by beneficial bacteria. These complexes are then either biodegraded, if indigenous bacteria are present, or



will be chemically broken down if oxidizing or reducing chemistries are present in the complex. This action can literally turn the pipelines into an extension of the treatment plant and can reduce the load on the downstream facility.

PROVIDING A SOLUABLE FOOD SOURCE

The Neozyme formulation provides a powerful emulsifying action that produces soluble sources of food to downstream treatment plants. The bio-emulsifiers and catalysts break down particles of fats and suspended BOO into soluble components. The short retention time normally occurring within the collection system limits this action to mostly fats and greases. This is beneficial because these are generally considered downstream nuisances and are a burden on the treatment plant biomass. Utilizing NEOZYMES™, the biomass within the treatment plant does not have to generate as many bio-emulsifiers because the biomass food source arrives at the plant in a more absorbable form. Fats are especially easy to break down through the Neozyme enzyme / co-enzyme catalytic reactions. Less fats lead to less maintenance and higher flow rates. Solids degradation utilizes far less concentrations of surfactants than conventional actions because of the Neozyme complex. In most reactions, the NEOZYMES™ complex utilizes the self-organizing structure of its components to come together to create a reaction, then to split apart and form elsewhere, performing another reaction without being consumed. This catalytic reaction continues *until* there are no further reactions or until the components are ultimately consumed as food by bacteria.

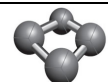
ENHANCEMENT OF ODOR-REDUCING CHEMISTRIES

Because the NEOZYMES™ complex is self organizing, it brings together the contaminant, biocatalysts, oxygen and other chemical compounds. The catalysts cause degradation reactions to occur after which the complex breaks apart to then form again with another contaminant. This sequential series of reactions allow the NEOZYMES™ to be used in very low concentrations.

In a force main, because of the lack of oxygen, compressed air or a stream of oxygen rich water mixed with ECOSYSTEM PLUS® (ESP) through a simple, inexpensive eductor is applied to the pressurized line. The pressure dissolves the gas rapidly and forms reserve available oxygen in the Neozyme microbubbles. For example, chemical oxidation of sulfides into sulfates or sulfur is a very straightforward reaction using the Neozyme micro bubbles. Normally, existing H₂S combines with the water and air interface in the treatment system pipe producing H₂SO₄, sulfuric acid, which corrodes pipes and pumps. In a NEOZYMES™ driven reaction, the hydrogen sulfide combines with oxygen and forms water and sulfur instead ($2\text{H}_2\text{S} + \text{O}_2 \rightarrow 2\text{H}_2\text{O} + 2\text{S}$). Another likely reaction is the formation of hydrogen and sulfate ($\text{H}_2\text{S} + 2\text{O}_2 \rightarrow 2\text{H} + \text{SO}_4$). Because of the complexity of wastewater, there are innumerable additional combinations of these compounds with other contaminants, making it difficult to accurately predict the ratio of air and NEOZYMES™ to H₂S or ammonia required for these reactions without field-testing. NEOZYMES™ *dramatically reduce the amount of air required for these reactions* thus reducing the probability of air locking of downstream devices, a problem with air injection control of odor in the past.

APPLICATION FOR HYDROGEN SULFIDE CONTROL

Neozyme International, Inc. believes that the application of its product will *alleviate* the hydrogen sulfide problem common in most sewer systems. The addition of ESP into the wet wells that feed into troubled lift stations will minimize the introduction of H₂S and sulfide. We recommend upstream sites as primary injection points. However, there is no easy way to pilot test the recommended applications, and lab scale testing cannot accurately predict scale-up usage. Furthermore, treatability testing on part of a collection system may not be physically representative of the entire system's problems or treatment indications. Full-scale treatment is the recommended approach for proof of efficacy. There are presently several municipal systems using the Neozyme products in similar situations.



Testing Protocol

A full-scale test should include injection of ESP into the wet wells of all lift stations and on all lift stations surfaces. A two to three week period is the normal treatment period before the pipes are purged and the cleaning portion of the reaction has reduced the existing levels of biofilm or H₂S. This initial cleaning treatment is generally performed with a dose of three times (3X) the expected maintenance doses. After this period, the dosage of Neozyme products should be reduced to a level that can sustain conditions that are desired. Levels of fats, oil and H₂S will be monitored during this entire period and modifications to the dosage rates are incorporated once this data is accumulated. Maintenance doses as low as 0.5PPM are typical.

Additional Benefits

Reduction of Volatility and Flammability

When treating for H₂S removal, there will also be some reduction in accumulated hydrocarbons and fats, oil and grease (FOG) by the same mechanisms as described before. This reduction reduces the volatility and flammability of fuels and other VOCs. The extent of this is dependent on the type and age of the FOG, the amount of surface area covered by FOG, the mechanical limitations of velocities and pipe volume and many other factors. Fats are broken down through an enzyme / coenzyme catalytic reaction that reduces fats to fatty acids and glycerin, and if the environment in the pipes can be kept at an active aerobic state, there will be a significant degradation in fats and oil.

Question: How does a product such as Neozyme work on reducing floating FOG when the product is heavier than water? The reactions described above treat only from below. An alternative method is to treat from both below the surface and to treat with a spray solution from above. This breaks down fats and oils from both directions and will maintain an oil free environment. High concentrations of hydrocarbon will increase the time required for the reduction to occur yet treating both the surface and the bulk water phase will reduce the time involved. Fats that accumulate at pipe crowns must be treated by flooding the pipes occasionally. However, this may occur at regular intervals naturally due to rain infusion or seasonal loads.

Simple Application

The Neozyme formulas are generally injected with a simple chemical feed pump and, in many cases, can be fed directly from the original container. The products are a liquid concentrate and will usually perform better if diluted and applied in a solution of water. This increases the dispersion of the product. This is especially true in situations such as hydrogen sulfide control because the dosages are generally under 5 PPM. Spray systems using normal city water pressures and siphon pumps to dilute the product have also been used successfully for surface applications.

CONCLUSION

NEOZYMES™ provide a cost effective solution to hydrogen sulfide, ammonia and mercaptan odor control in collection systems, with the added benefits of slime, fat and grease reduction; other odor elimination; reduced suspended BOD and increased effective pipe diameter. Effective dosages can be as low as 0.5 PPM. The mechanism actually reduces the source of the odor instead of treating the symptom.

In most applications, there is no need for expensive make down systems or large storage tanks. The product is non-toxic, biodegradable and completely safe to handle. NEOZYMES™ actually reduce the volatility and flammability of fuels on the surface of water.

The Neozyme products do not add any nitrate, COD or BOD loads on downstream systems and there are no corrosive or highly oxidative chemicals in the formulations that can cause reactions or explosions with hydrocarbons.

USDA APPROVED for use in sewage and/or drain lines of official establishments operating under the Federal Meat, Poultry, Egg Shell Grading and Egg Product Inspection Programs.

