KATHON™ FP 1.5

FUEL PROTECTION MICROBICIDE

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KATHON™ FP 1.5 from Rohm and Haas is a patented, high performance antimicrobial agent developed specifically to combat problems of microbial contamination and spoilage in hydrocarbon fuels. The effectiveness of KATHON® FP 1.5 has been proven over a number of years and it has extensive approvals endorsing its use in a wide range of fuel types.

KATHON™ FP 1.5 combines exceptional activity with broad spectrum performance. Consequently it is effective at very low use levels against all commonly occurring fuel contaminants (bacteria, fungi and yeast). Furthermore the active ingredients of KATHON™ FP 1.5 are non-persistent in the environment thus giving the product good environmental acceptability.

The unique combination of benefits that KATHON™ FP 1.5 offers has enabled it to become established as the leading microbicide for fuel preservation.

1. KATHON™ FP 1. 5: EXPERIENCE AND EXPERTISE COMBINED

KATHON™ FP 1.5 from Rohm and Haas is the world's leading fuel microbicide. It is a highly effective and versatile product and has been successfully used in a wide range of fuel types. The summarised case histories below confirm its outstanding performance.

Case History 1

In the mid 1980's a major Western European Navy was experiencing an increasing number of problems attributed to microbial growth in their fuel storage systems. Having identified the nature and cause of the problem a trial was set up to identify the most effective biocide. Effectiveness was measured in terms of:

a) Cost efficacy.
b) Performance, measured by reduction in microbial counts plus ATP level.

A tank containing 14,000 m^3 of fuel was treated with KATHON™ FP 1.5. This treatment eradicated water bottom contamination within 5 hours and contamination in the fuel within 24 hours. During the remaining 20 weeks of the trial there was no recurrence of the problem.

On the basis of this performance KATHON™ FP 1.5 was selected as the biocide of choice. It has since been regularly used on an additive basis, to ensure that strategic military and civil fuel reserves remain free from microbial contamination.

Case History 2

Early in 1990 an aircraft from an Eastern European air force suffered an engine failure immediately prior to take off. Subsequent analysis showed that microbial contamination of the fuel had caused the engine failure.

KATHON™ FP 1.5 was used to clean up the fuel storage system involved in the incident. This force now treats its fuel on an additive basis with KATHON™ FP 1.5 in order to avoid recurrence of this type of problem.

Case History 3

A major multinational oil company recently experienced persistent contamination problems in a diesel fuel distribution system. The problems were most apparent at end user level, however investigation showed that the whole distribution network from refinery storage downwards had become contaminated.

Curative treatment with KATHON™ FP 1.5 was used to eradicate contamination. This was followed by an extended period of continuous additive dosing to the refinery storage tanks. Dosing at this point ensured that the fuel remained protected as it was transferred through the distribution system. For the duration of the trial the fuel remained free from contamination at all stages - right through to the end users.

Once the biocide treatment was removed the contamination problems rapidly returned.

Case History 4

In 1989 microbially contaminated fuel brought buses in a European capital city to a standstill. Over a 5 month period a number of vehicles from the local public transport company encountered problems caused by blocked fuel lines and filters. Eventually microbial contamination in the central fuel storage system was identified as the source of these problems.

Treatment with KATHON™ FP 1.5 successfully cleaned up the system. KATHON™ FP 1.5 has subsequently been used on a regular basis to ensure that the stored fuel remains free from contamination.

These 4 cases give an insight into the comprehensive all round performance of KATHON™ FP 1.5. They also confirm that KATHON™ FP 1.5 is the leading microbicide for fuels.

Reflecting its world leading status, KATHON™ FP 1.5 has wide ranging approvals from both regulators and manufacturers*. These approvals confirm the suitability of KATHON™ FP 1.5 for use, in such stringently controlled fuels as Jet Al and Military diesel.

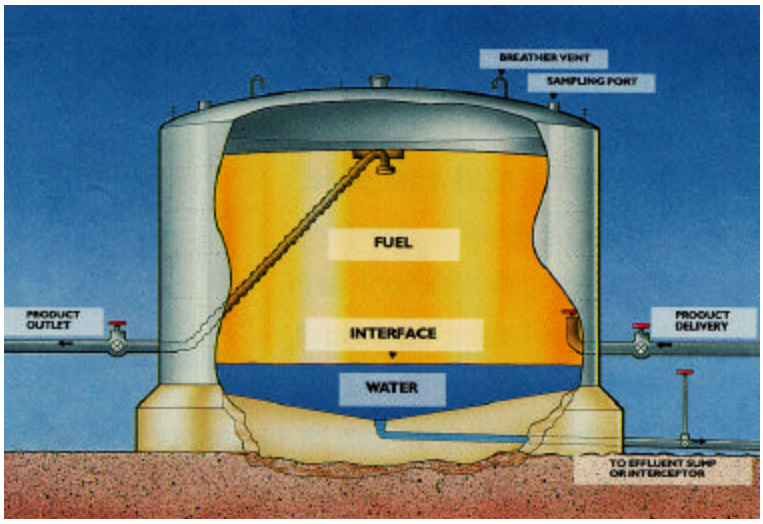
KATHON™ FP 1.5 is based upon isothiazolone chemistry and technology that is unique to Rohm and Haas. It is an area in which we have unrivalled experience and expertise. This has enabled us to develop a comprehensive support package: customers are offered advice and assistance in areas such as safety, handling, disposal, environmental fate and toxicology. Our aim is to ensure that our products are used in the safest and most effective manner.

KATHON™ FP 1.5 from Rohm. and Haas is part of a range of isothiazolone-based biocides that cover an array of application areas from cosmetics to antifouling paints. All of these products are manufactured to the highest specifications in our ISO 9002 accredited plant in the North East of England.

* Full details of approvals and manufacturers endorsements for KATHON™ FP 1.5 are included in a separate bulletin.

2. DEVELOPMENT OF MICROBIAL GROWTH IN FUELS

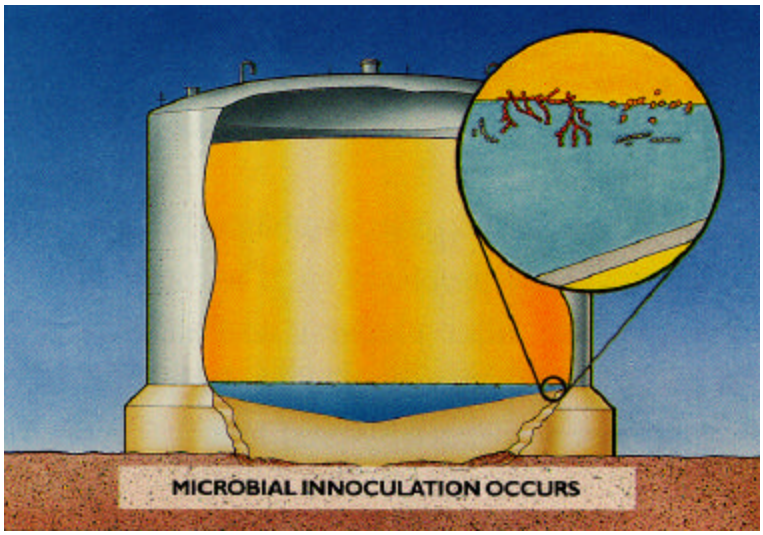
Microbial contamination is not specific to any one fuel type - marine, aviation, automotive and home heating fuels are all susceptible. Similarly there is no single specific organism that can be identified as being responsible for degradation and spoilage. As a general rule, wherever fuel and water come into contact in a storage or distribution system microbial contamination is likely to occur.



No matter how well maintained a storage system is, a water bottom is almost invariably present. This results from a number of sources:

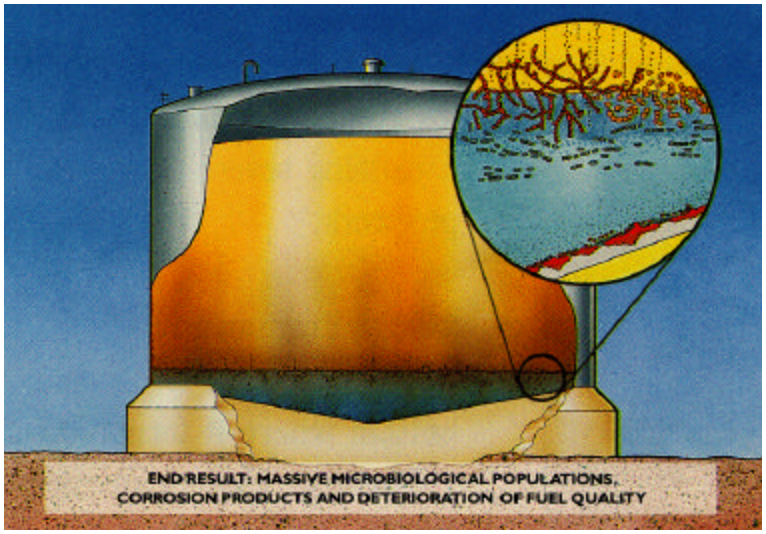
- Freshly refined fuel contains some water. This separates out as the fuel cools down.
- Atmospheric condensation: humidity in the air in the storage tank condenses out and adds to the water bottom.
- Rain or snow may enter the tank via sampling ports, breather vents or ill -fitting seals on floating roofs.
- Transport or storage in tankers or barges can result in contamination from ballast water.

In addition certain end use applications - notably marine fuel - provide opportunities for water to enter a storage system.



Water from all of these sources accumulates in the storage tank to form the water bottom.

Microorganisms can be air or waterborne. Consequently as the water bottom develops a microbial population builds up in it. For many of the species present in the water bottom, liquid hydrocarbon fuels represent an excellent nutrient source. As a result there is a population explosion: the microorganisms proliferate at the fuel/water interface, surviving in the water phase whilst feeding on the fuel.



In the initial stages of contamination the organisms present are predominantly aerobic, using the dissolved oxygen in the water for respiration. As this supply of oxygen is depleted, anaerobic organisms, known as sulphate reducing bacteria, develop. These organisms do not require oxygen for respiration and form corrosive waste products such as hydrogen sulphide.

3. CONSEQUENCES OF MICROBIAL GROWTH

Once a microbial population becomes established fuel quality rapidly deteriorates. As outlined below problems such as haziness, failure to meet specifications, corrosion, filter plugging and additive degradation can occur. All of these problems are related directly to the presence of microorganisms or their associated by-products.

Fuel Haziness:
This is a clear indication that fuel is out of specification. The primary cause of haziness is an increase in the water content of the fuel resulting from the production of biosurfactants. These are by-products of microbial growth and alter the surface tension at the fuel/water interface. As a consequence the solubility of water in the fuel is increased.

Degradation of Additives:
Certain additives, especially those rich in nitrogen and/or phosphorous, encourage microbial growth. In the process the additives are degraded and consequently their effect is lost.

Microbially Induced Corrosion:
Hydrogen sulphide is produced by sulphate reducing bacteria. This enters solution and is highly corrosive, causing severe pitting of fuel tanks and pipework.

Sludge Formation:
Microbial debris is deposited on the tank bottom where it forms a layer of sludge. This sludge creates an environment which favours microbially induced corrosion. It may also become contaminated with viable microorganisms and unless removed will act as a reservoir of infection every time the tank is used.

Filter Plugging:
Biopolymers are formed during microbial growth. These are gummy products which, along with microbial and other debris, are deposited on filters and pipes leading to reduced flow rates and blockages. At end user level this can have serious consequences causing engine damage and in extreme cases complete failure.

Odour:
A problem commonly associated with microbially contaminated fuel is that of foul odour. This is principally as a result of hydrogen sulphide production by sulphate reducing bacteria.

4. OTHER FACTORS INFLUENCING MICROBIAL CONTAMINATION

Although microbial spoilage and contamination occurs in a wide range of fuel types, some have been found to be more susceptible than others. For example, straight chain paraffins tend to be more readily degraded than aromatics and olefins.

The duration and conditions of storage are also important. If there is a low turnover of a stored fuel, such as in a strategic reserve, contamination is much more likely to develop. Poorly maintained or outdated storage facilities also present greater opportunities for contamination.

In the majority of cases, in addition to the microbial contamination at the fuel water interface there is a sessile population attached to the tank walls. This is frequently overlooked. Unless treated it will act as an innoculum reservoir for future contamination.

4. KATHON™ FP 1.5: PERFORMANCE BENEFITS

KATHON™ FP 1.5 offers a number of outstanding performance benefits.

Broad Spectrum Activity: KATHON™ FP 1.5 is effective at very low use levels against all microbial species (bacteria, fungi, yeasts) commonly encountered in fuel systems. Full details of minimum inhibitory concentration values of KATHON™ FP 1.5 against a range of microorganisms are given in Appendix 1 at the end of this bulletin.

Rapid Inhibition of Microbial Growth and Enzyme Synthesis: KATHON™ FP 1.5 causes immediate inhibition of growth on coming into contact with a microorganism. Growth inhibition rapidly becomes irreversible and results in cell death.
The time to achieve eradication varies according to the extent of contamination and the type of microorganisms present. Typically, as the graphs below indicate, within 6 - 36 hours of treatment the fuel will again be fit for use.

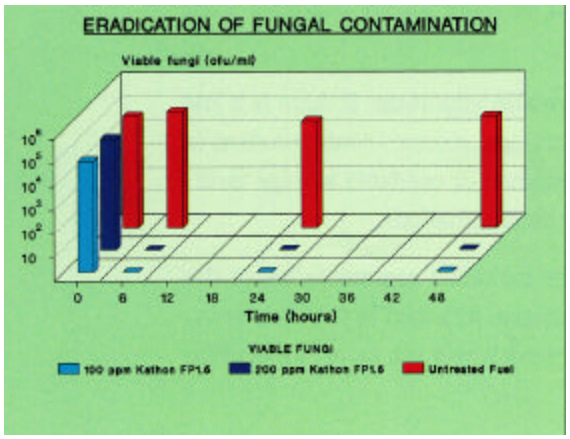


Figure 1

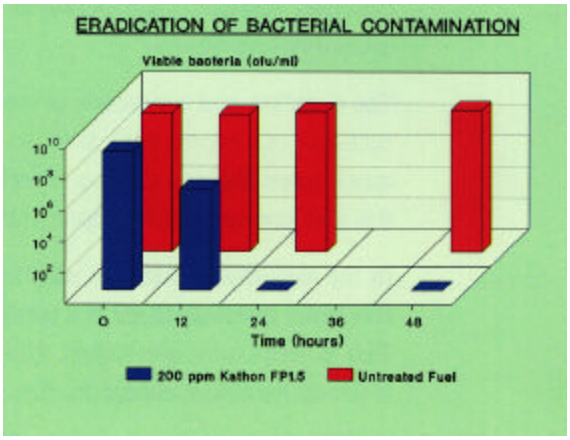


Figure 2

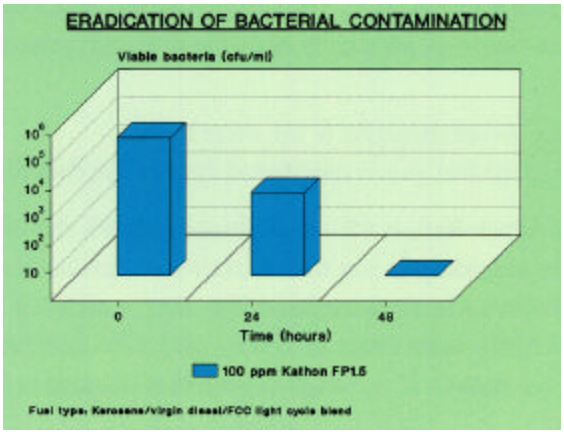


Figure 3

Long Term Preservation: Fuel treated with KATHON™ FP 1.5 will remain protected from contamination over extended periods of time. It will also resist contamination if re-inoculated from another source.

In studies conducted over an 8 week period, contaminated fuels were treated with fuel biocides. The fuel treated with KATHON™ FP 1.5 remained free from contamination for the duration of the trial. None of the competitive products evaluated could match this performance.

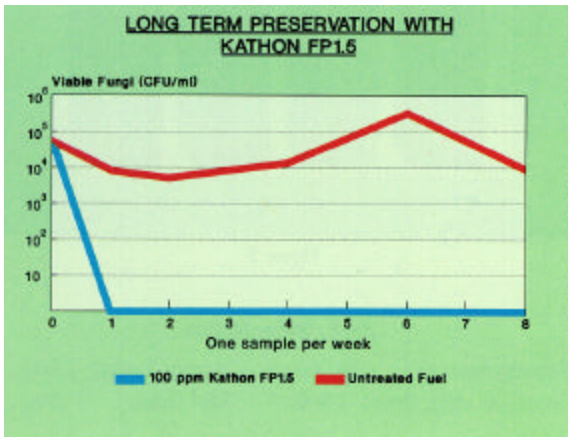


Figure 4

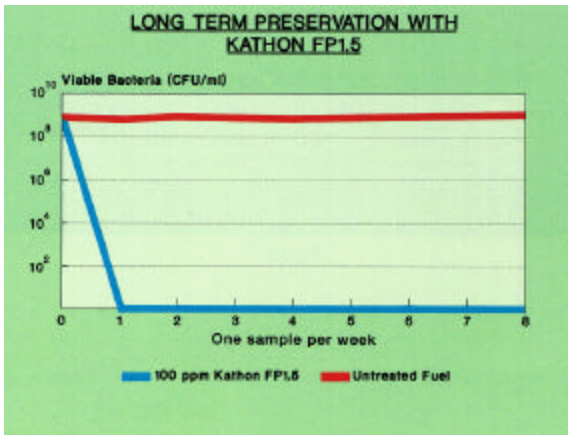


Figure 5

Complete System Protection: The partitioning characteristics of KATHON™ FP 1.5 ensure that it is present in both the fuel and water phases. This enables:
a) Eradication of contamination in the water bottom.
b) Protection of the fuel as it is transferred through the distribution system.

The extent to which KATHON™ FP 1.5 partitions between the fuel and water phases varies according to the fuel/water ratio. Results from computer modelling, shown in figure 6, indicate that after a series of 10 transfers between 60% (fuel/water ratio of 100/1) and 97% (fuel/water ratio of 10, 000 / 1) of the KATHON™ FP 1.5 originally dosed is retained in the fuel.

Data generated in the field support this model. Fuel was treated at refinery storage level. It was then transferred through the usual distribution system. Analysis of the fuel was carried out at 3 points in the system. As can be seen from figure 7, at end user level almost 88% of the original active ingredient dosed was present.

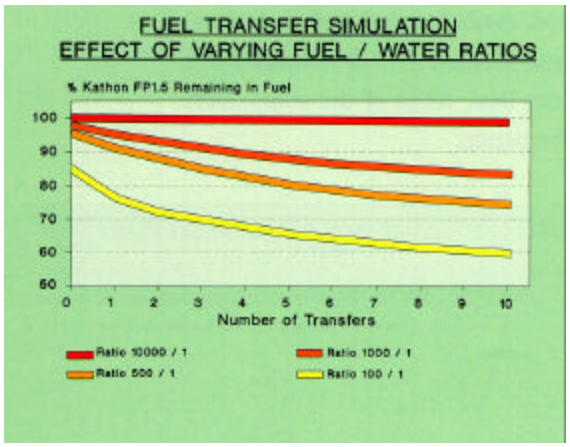


Figure 6

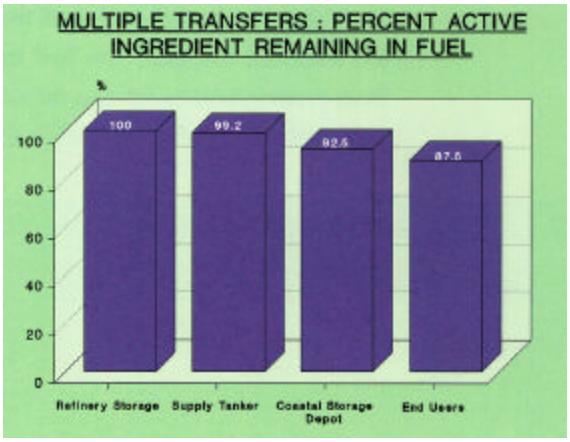


Figure 7

Fuel: Water Ratios

Refinery Storage	10,000: 1	Supply Tanker	1,000 : 1
Coastal Storage Depot	1,000 : I	End Users	500: 1

This shows that fuel treated with KATHON™ FP 1.5 remains protected as it is transferred through the distribution chain.

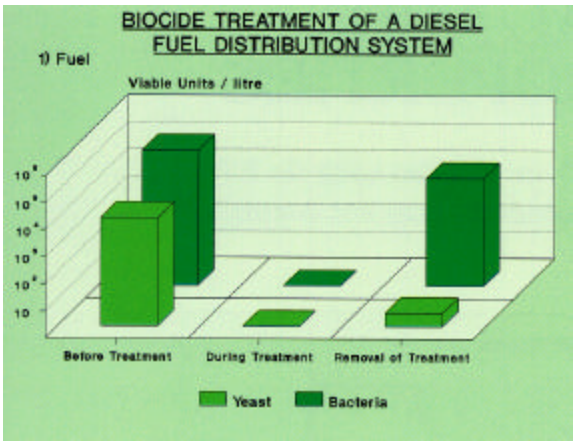


Figure 8

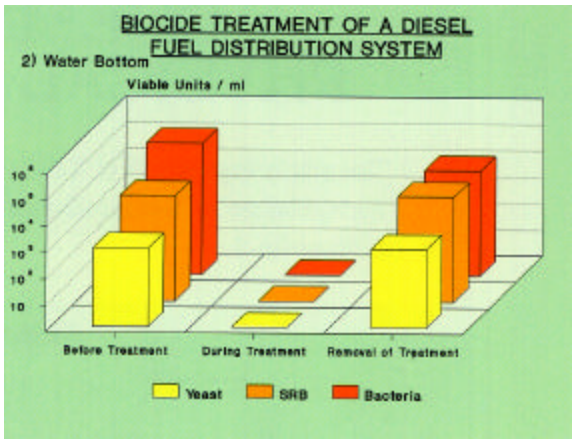


Figure 9

Results from a customer trial show the impact on contamination at an intermediate storage facility that was receiving fuel dosed with KATHON™ FP 1.5.

As can be seen, initially the system was heavily contaminated, however whilst receiving the treated fuel this was eradicated. Once the treated fuel was removed, contamination quickly returned (Fig. 8 and 9).

Proven Effectiveness: As indicated earlier in this bulletin history of use confirms the outstanding performance of KATHON™ FP 1.5 in a variety of applications.

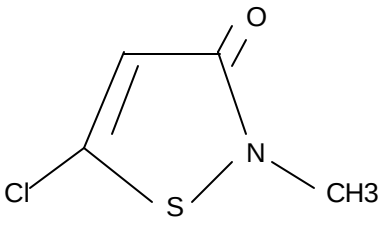
Widely Approved: KATHON™ FP 1.5 has wide ranging approvals endorsing its use in aviation, marine, automotive, home heating and military fuels. Full details of approvals for KATHON™ FP 1.5 are contained in a separate bulletin.

Safety and Support: Rohm and Haas offers customers a comprehensive package of support services and data to promote the safe and effective use of KATHON™ FP 1.5. This includes extensive data on environmental fate, toxicology and materials compatibility and advice and assistance in areas such as disposal, product handling and delivery/dosing systems.

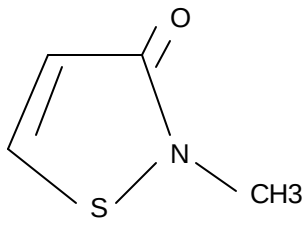
6. CHEMICAL AND PHYSICAL PROPERTIES

The active ingredients of KATHON™ FP 1.5 are identified using the IUPAC nomenclature as 5-chloro-2-methyl-4-isothiazolin-3-one and 2-methyl-4-isothiazolin-3-one.

Structural Formulae



5-chloro-2-methyl-4-isothiazolin-3-one
CAS Registry N° 26172-55-4
EINECS N° 2475007



2-methyl-4-isothiazolin-3-one
CAS Registry N° 2682-20-4
EINECS N° 2202396

Properties of KATHON™ FP 1.5

Appearance	Yellow Liquid
Odour	Mild
pH (as produced)	4-6
Specific Gravity (25°C)	1.04
Viscosity (25°C)	97.8 CpS

These values do not constitute specifications.

7. MATERIALS COMPATIBILITY

KATHON™ FP 1.5 has been tested extensively in fuels and with fuel system components. At recommended use levels KATHON™ FP 1.5 has no deleterious effects on these.

Examples of materials tested:

Coatings	Vinyl ester Epoxy
Elastomers	Buna-S-rubber PVC
Plastics	Fumarate Polyester
Polyolefins	High Density Polyethylene

For detailed information on materials compatibility please consult the Safety Guidelines Bulletin for KATHON™ FP 1.5.

8. DOSING INSTRUCTIONS

Curative Treatment: For heavily fouled systems, treatment levels of 150 -300 ppm KATHON™ FP 1.5 should be used. This dosage may need to be repeated periodically to maintain control of these microorganisms. Grossly contaminated systems may require physical cleaning to remove debris.

Additive Treatment: Continuous dosing with 100 - 150 ppm KATHON™ FP 1.5 will ensure that a distribution system remains free from microbial growth.

General Recommendations: Whatever method of addition is employed appropriate precautions should always be taken.

- Avoid any dermal contact. Suitable protective clothing should be worn (including rubber gloves and safety goggles/face shield).

- Do not exceed solubility level of KATHON™ FP 1.5 (approximately 5000 ppm or 5 kg KATHON™ FP 1.5 / 1000 kg of fuel).

- Fuel tanks being treated with KATHON™ FP 1.5 should be at least 10% full. Never dispense KATHON™ FP 1.5 into an empty fuel tank.

- Do not exceed recommended dose levels for KATHON™ FP 1.5.

Road Vehicles: It is impractical to dose KATHON™ FP 1.5 directly into vehicle fuel tanks. Instead fuel treated with KATHON™ FP 1.5 should be used.

Marine Vessels: Wherever feasible fuel tanks should be cleaned. As with road vehicles, direct addition of KATHON™ FP 1.5 may be impractical. The use of fuel treated with KATHON™ FP 1.5 is therefore the preferred method of addition.

Storage Tanks: In order to optimise distribution of KATHON™ FP 1.5 addition into a flowing fuel stream is preferred. Either slug or continuous feed dosing can be used. It should be noted however that other methods of addition, such as dumping, will not affect the performance of KATHON™ FP 1.5.

NB: KATHON™ FP 1.5 is not surface active. It will therefore encourage rather than inhibit water separation.

9. DISPOSAL OF STORAGE TANK EFFLUENTS

The partitioning characteristics of KATHON™ FP 1.5 result in a higher concentration of active ingredient in the water phase than in the fuel phase. The exact concentration is dependent on several factors. The fuel/water ratio, the initial dose, length of storage rate of turnover and conditions within the tank will all influence the way the active ingredients partition between fuel and water.

As with most biocides at certain concentrations KATHON™ FP 1.5 can be toxic to aquatic species. Therefore water bottoms or effluents must be diluted and/or deactivated prior to discharge into public waters.

Dilution: KATHON™ FP 1.5 is biodegradable and is non-persistent in the environment. Dilution to below effect levels will ensure its degradation - the greater the dilution factor the more rapid is the degradation. For guidance on approved discharge procedures contact Rohm and Haas or consult local authorities.

Deactivation: The active ingredients of KATHON™ FP 1.5 are readily degraded to non toxic components by the addition of slightly acidic 10% solution of sodium metabisulphite ($Na_2S_2O_5$) or sodium bisulphite ($NaHSO_3$) in the ratio of 4:1 deactivation solution: KATHON™ FP 1.5.

Deactivation must not take place in the storage tank.

When KATHON™ FP 1.5 is used at refinery level another simple deactivation procedure can be employed. Water bottoms containing KATHON™ FP 1.5 should be passed into waste waters from the hydrodesulphurisation process. The high levels of hydrogen sulphide levels present result in rapid deactivation of KATHON™ FP 1.5.

10. TECHNICAL ASSISTANCE

Rohm. and Haas European Laboratories, located in Southern France, are available to provide specialised technical support to all of our customers. Services available include:

- Identification of sources of contamination.
- Design of treatment programs to meet specific needs.
- Monitoring of KATHON™ FP 1.5 levels in fuel samples.
- Advice and assistance on procedures to avoid the recurrence of microbial growth.

Specific or particularly heavy service requirements should be discussed with Rohm. and Haas in advance. In the event that high levels of routine testing or a permanent presence on site are required, Rohm. and Haas will be pleased to recommend a company specialised in the provision of these services.

11. APPENDIX I

MINIMUM INHIBITORY CONCENTRATION VALUES FOR KATHON® FP 1.5 AGAINST COMMONLY OCCURRING FUEL CONTAMINANTS

Results of MIC of KATHON™ FP 1.5 vs. 9 test microorganisms in supplemented (sodium acetate plus yeast extract) Bushnell-Haas medium

Organism Type	Organism	ATCC #	MIC - ppm AI
Mold[a]	*Hormoconis resinae*[c]	22712	3
Yeast[b]	*Candida albicans*	16651	1.5
	Candida lipolytica[c]	16617	1.5
Bacteria[b]	*Citrobacter freundii*	6750	1.5
	Enterobacter aerogenes	13048	0.375
	Escherichia clfi	11229	1.5
	Proteus mirabilis	4675	1.5
	Pseudomonas aeruginosa[c]	33988	0.375
	Pseudomonas oleoverans	8062	0.375

a: MIC at 7 days / b: MIC at 48 hours / c: Hydrocarbon utilizing microorganism

Product: Biocides - KATHON™ FP 1.5
Diesel Fuel # 2 Supreme

Active Ingredient: 5-chloro-2-methyl-4-isothiazolin-3-one
2-methyl-4-isothiazolin-3-one
Total Active Ingredient (Typical Value) 1.5%

Recommended Use Levels: 50 - 300 ppm KATHON™ FP 1.5

12. APPENDIX II

PACKAGING

KATHON™ FP 1.5 **is available in the following pack sizes.**

5 kg Flask / 20 kg Pail / 110 kg Drum / 200 kg Drum / 1000 kg Tote

Advice on the handling of these containers is given in the Safety Guidelines Bulletin for KATHON™ FP 1.5. Should you require any further information please contact your local Rohm. and Haas office.

These suggestions and data are based on information we believe to be reliable. They are offered in good faith, but without guarantee, as conditions and methods of use of our products are beyond our control. We recommend that the prospective user determine the suitability of our materials and suggestions before adopting them on a commercial scale
.
Suggestions for use of our products or the inclusion of descriptive material from patents and the citation of specific patents in this publication should not be understood as recommending the use of our products in violation of any patent or as permission or license to use any patent of the Rohm and Haas Company

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