

Tanker Operator Hamburg Conference 2015

Cases of increased wear due to Cat Fines avoidable by on-board fuel condition monitoring

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Background Information

Cat Fines = Catalytic Fines are used in the refinery process (cracking process)

- Cat Fines are catalysts, usually aluminum and silicon compounds
- They are used in the catalytic cracking process
- long hydrocarbon molecules are broken down into many smaller low-boiling molecules
- Simply spoken; hydrocarbon cracking is the process of breaking long-chains of hydrocarbons into short ones...



Background Information

Cat Fines = Catalytic Fines are used in the refinery process (cracking process)

- The rate of cracking and the rate of the end products are strongly dependent on the temperature, pressure and presence of catalysts...
- But Cat Fines in tribological friction systems are extremely abrasive
- That's one reason why they have to be removed from the residue fuel after the refining process



Background Information

Cat Fines remain in residual fuels like HFO up to a certain quantity

- The reason for this is a simple commercial one
- It is technically possible to remove nearly all remaining Cat Fines from the residual fuels – ultimately it is a question of costs
- On the other hand, all seagoing vessels are equipped with an onboard fuel treatment system



monitoring systems

Onboard fuel treatment system

Includes settling, purification and filtration



Specification ISO 8217:2012 for Residual Marine Fuels

Improved safety through ISO specification regarding Cat Fines

latest specification ISO 8217: 2012, Table 2- Residual Marine Fuels

					Table 2	(continu	ied)							
Characteristic	Unit	Limit	Category ISO-F-											
			RMA	RMB	RMD	RME	RMG				RMK			lest method
			1 0ª	30	80	180	180	380	500	700	380	500	700	
Sodium	mg/kg	max.	50	100	100	50	100				100			see 7.8 IP 501 IP 470
Aluminium plus silicon	mg/kg	max	25	40	40	50	60				60			see 7.9 IP 501, IP 470 or ISO 10478

There is, however, a <u>discrepancy</u> between the maximum acceptable levels of Cat Fines as stated in common marine fuel specifications such as the ISO 8217 and those recommended by engine manufacturers, which are typically 10-15 ppm...

Regulations of the engine builders

Statements of the leading main engine makers MAN, WÄRTSILÄ and others

MAN Diesel & Turbo

"....The Cat-fines level should be kept as low as possible before the engine inlet, and the maximum level is 10 ppm..."





Regulations of the engine builders

Statements of the leading main engine makers MAN, WÄRTSILÄ and others:

• WÄRTSILÄ

"...Practical experience has shown that with proper treatment in the fuel oil separator an aluminium and silicon content of 80 mg/kg, ..., can be reduced to 15 mg/kg, which is considered as just tolerable..."



<u>Source:</u>Notes to "Fuel Oil Requirements" 29.51.07.40 – V.2007



Danger of Cat Fines

Affected engine components

- Statistics of high cylinder and piston ring wear cases show that in nearly 90% of these cases Cat Fines particles embedded in the liner and piston ring surface are "responsible" for the wear.
- Cat Fines injected into the engine affecting the wear of engine components like:
 - cylinder liners
 - o pistons (including piston ring grooves)
 - piston rings

but also increased wear of fuel pumps, fuel injectors and fuel valves



New MAN SMC engine piston crown & skirt damage due to Cat Fines after 1000 operating hours

Source: Shree Engineering Services



Danger of Cat Fines

Differences between the wear mechanism of the different engine types

At large slow speed Diesel engines

- <u>Larger components</u>, especially <u>fuel injection components</u> enable even "larger Cat Fines" to enter into the combustion chambers
- The optimized, cost effective <u>cylinder oil feed</u> rate of the slow speed engines lower the efficiency of the Cat Fines wash down effect of the scrape down oil at the cylinder liner

Catalytic Fines embedded in the surface of a piston ring.



Source: Marine diesel engines, Catalytic Fines and a new standard to ensure safe operation 2005-05-26 Royal Belgian Institute of Marine Engineers



Differences between the wear mechanism of the different engine types

At medium and high speed Diesel engines

- The wash-off effect of the <u>splash oil lubrication</u> is better able to remove Cat Fines from the cylinder liners
- <u>Smaller tolerances of most of the components prevent the entry of</u> larger Cat Fines

Abrasive wear in FIP plunger with visible scratches caused by fuel with Cat-fines: zoom x10



Source: Zeszyty Naukowe Akademii Morskiej w Szczecinie 41 (113)



The largest bunker regions in the world are influenced by the Sulphur regulations:



The Sulphur regulations influence the quality of HFO regarding Cat Fines

- The Sulphur regulations influence the quality of HFO to fulfil the sulphur requirements in SOx ECAs
- With a decrease in the global fuel Sulphur content, a corresponding increase can be seen in the Cat Fines trend.



The largest bunker regions in the world are influenced by the Sulphur regulations:

- The largest bunker regions in the world are influenced by the Sulphur regulations
- Also visible the differences in the Cat Fines content in low- and high-sulphur HFO



High content of Cat Fines in all residual fuel grades

- The high content of Cat Fines can be found in all residual fuel grades
- The lighter grades have on average a lower concentration of Cat Fines compared to the higher viscosity grades
- 40% of the most popular grade RMG 380 contains 21-40 ppm and close to 20% contain 41-80 ppm Cat Fines



Onboard fuel treatment system

Requirements on ship's staff and ship's equipment

- There is a strong need for <u>improvement of the efficiency of the</u> <u>onboard fuel oil treatment</u> due to the danger to the a.m. engine parts and increasing amount of Cat Fines in HFO
- The HFO cleaning system (settling tanks, filters and separators) must be <u>designed and operated efficiently</u> to remove the relevant numbers of Cat Fines in the HFO of different sizes – down to the engine makers requirements.
- The <u>fuel oil temperature</u>, the <u>fuel oil flow through</u> the filters, separators etc. as well as <u>the condition of the filters</u> and separators are significant factors in the overall operational efficiency of the cleaning systems.

Onboard fuel treatment system

Requirements on ship's staff and ship's equipment

- Serious engine damages proven to be originating from Cat Fines even occur on vessels that have <u>never bunkered HFO with impermissible</u> <u>concentrations of Cat Fines</u>.
- The reason here is <u>natural sedimentation</u> of the Cat Fines in the fuel storage tank systems of the vessels.
- This causes in combination with the <u>rolling and pitching</u> of the vessel in rough weather to periodical high concentrations of Cat Fines which reach the day tanks via bunker and settling tanks.



Requirements on ship's staff and ship's equipment

Improvements by more efficient fuel treatment equipment for new buildings:

Tanks:

- Size
 - > Sufficient empty tanks to store new purchased fuel to avoid blending
- Numbers
 - > 2 settling tanks will increase the settling time
- Design
 - Settling tanks with inclined bottoms (so called sloping bottoms) to prevent build-up of sediments and Cat Fines in the bottom
 - The day tank overflow pipe must go down to the bottom for continuous cleaning of the tank bottom
- Operation
 - Continuous and periodical cleaning of the bottom of settling and day tanks
 - Maintaining the appropriate temperature in the system to aid settling in the tanks





Requirements on ship's staff and ship's equipment

Improvements by more efficient fuel treatment equipment for new buildings:

Separators and Filters:

- Size
 - Capacity should be sufficient with daily fuel consumption + 10%

• Operating:

- ➢ if possible run 2 purifiers in parallel
- > with minimum flow
- > at the optimal temperature (approx. 98°C)
- Fuel system filters should be regulary inspected and cleaned







Requirements on ship's staff and ship's equipment

Improvements by more efficient fuel treatment equipment during operation:

Equipment maintenance:

- Fuel treatment heaters should be cleaned regulary to ensure the optimal temperature for purification
- Purifiers and filters should be cleaned at scheduled intervals according to the manufacturers but more often if poor fuel quality is indicated
- Necessary spare parts for the fuel treatment system should be on board



Requirements on ship's staff and ship's equipment

Improvements by more efficient fuel treatment equipment during operation:

- New bunkers should be placed in empty tanks
- If blending is necessary compatibility tests should be carried out
- Drainage from automatic fuel backwash filters should <u>not</u> be reintroduced into the fuel treatment system
- Frequent **daily draining** of water and settled bottom sediments in service and day tanks is necessary
- Especially during heavy weather the amount of Cat Fines settled in the bottom of the tanks "at the way to" separator or engines exceeding the maximum accepted levels <u>– should be</u> <u>tested</u>



Onboard fuel treatment system – Tests

Requirements on ship's staff and ship's equipment

Improvements by more efficient fuel treatment equipment for new buildings:

Analysis and Tests:

- Fuel analysis <u>before bunkering</u>
 - Analyze the fuel quality of the port of supply by means of statistics available from/about the port of supply
 - Call for Bunker Certificates and check the parameters
- Fuel analysis <u>during bunkering</u>
 - Available on-board Cat Fines analysis equipment should be used - if not, take a sample for a laboratory tests Avoid using newly purchased fuel without available results of a fuel analysis!
- Fuel analysis during operation
 - Available on-board Cat Fines analysis equipment should be used



CMT on-board Cat Fines Test Kit

First available on-board Cat Fines Test Kit

With the CMT on-board Cat Fines Test Kit <u>it is</u> <u>possible now</u> to test the fuel at any of the following relevant points.

Namely:

- rapidly (less than 5 min)
- cost-effective
- exact (+/- 2 ppm)



Onboard fuel treatment system - Tests



- determination of the quantity of the Cat Fines during the bunkering process
- checking the conformity of the Cat Fines amount in bunker fuel according to ISO 8217

CMT monitoring systems

Onboard fuel treatment system - Tests



monitoring systems

checking the efficiency of the separator

Onboard fuel treatment system - Tests



• checking the conformity of the Cat Fines amount in the injected fuel according to the engine manufacturers regulation

CMT on-board Cat Fines Test Kit

First available on-board Cat Fines Test Kit

How is the test working?:

- 1st step: dilute the HFO
- 2nd step: add the Cat Fines reagent to the diluted HFO
- 3rd step: filter the above solution through a provided syringe filter
- 4th step:

measure the filtered solution in the Cat Fines Tester

The results will displayed in "ppm", accuracy +/- 2 ppm.







Cat Fines Problems - first available onsite Cat Fines Test Kit





Cat Fines Problems – first available onsite Cat Fines Test Kit

Available onsite fuel tests:

CMT Cat Fines Test

• content



- shaker
- syringes for 30 tests
- reagents for 30 tests
- vials for 30 tests
- filters for 30 tests
- cleaner for the OUTER SURFACE of the vials
- Cat Fines Tester



Cat Fines Problems - first available onsite Cat Fines Test Kit

≻1. dilute the HFO







fill reagent "J" in vial "1"



Cat Fines Problems - first available onsite Cat Fines Test Kit

≻1. dilute the HFO







fill HFO in vial "1" and shake by means of the shaker



Cat Fines Problems – first available onsite Cat Fines Test Kit

>2. prepare vial 2 with Cat Fines Reagent



• fill some Cat Fines Reagent in vial "2"



Cat Fines Problems - first available onsite Cat Fines Test Kit >2. bring Cat Fines Reagent and diluted HFO together



take some diluted HFO from vial "1" and fill it in vial "2" (vial "2" was before filled with Cat Fines Reagent)



Cat Fines Problems – first available onsite Cat Fines Test Kit

>3. filter Cat Fines Reagent and diluted HFO through the filter



- shake vial "2" with the shaker
- then take the content of vial "2" via the filter in vial "3"



Cat Fines Problems - first available onsite Cat Fines Test Kit

≻4. measure the filtered solution in the Cat Fines Tester















Thank you for your attention