Cat Fine Damage

Fortuity or Inevitable?

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What are we talking about?

INSTITUTE ADDITIONAL PERILS CLAUSES - HULLS

Loss of or damage to the Vessel caused by any ACCIDENT or by NEGLIGENCE, incompetence or error of judgment of any person whatsoever.

The assured only need to prove that the damage caused was accidental, without having to go into the specific reasons why

ACCIDENT = Incident that happens unexpectedly and unintentionally, resulting in damage or injury

UNEXPECTED = usually sudden event that occurs without intent or volition

Catalyst

- Small particles of Aluminum and Silica (Al+Si) compound 20 to 100 µm in size, DELIBERATELY introduced to 'crack' fuel, to improve the efficiency of refining and boost Sulfur removal.

- The catalyst is recovered by filtering/cyclone at the refinery for further use, however in the process some particles break-up and catalytic Fines are carried over within the residual fuel.

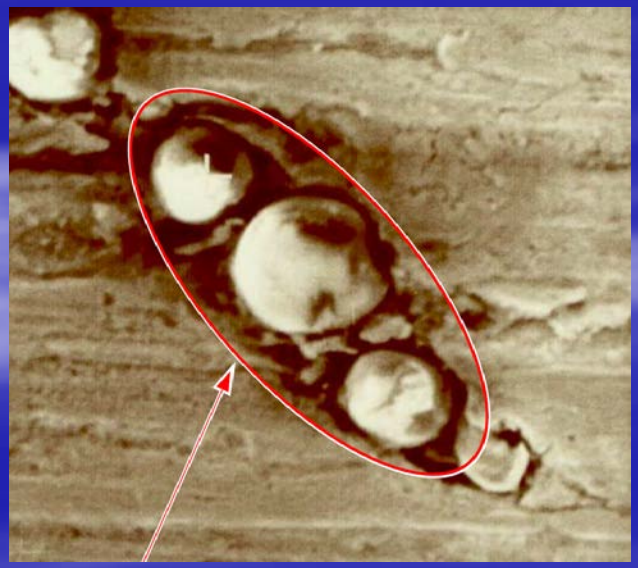
- Currently HFO are supplied with an limit of Al+Si of 60ppm

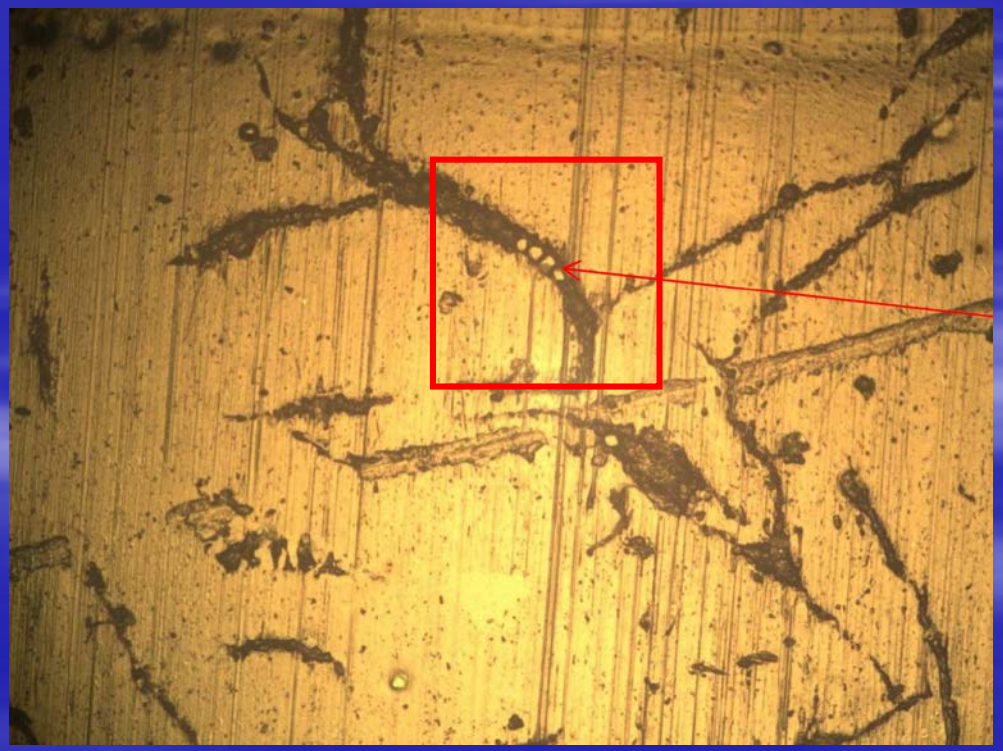
  Engine manufacturers require that fuel entering the cylinders should contain less than 15ppm Al+Si

  This should be obtained by purification on board

What is all About?

Cat fines are tiny, harder-than-steel particles contained in heavy fuels, lodging onto the running surfaces of cylinder liner and piston rings and permanently squeezed into the soft graphite lamellas.





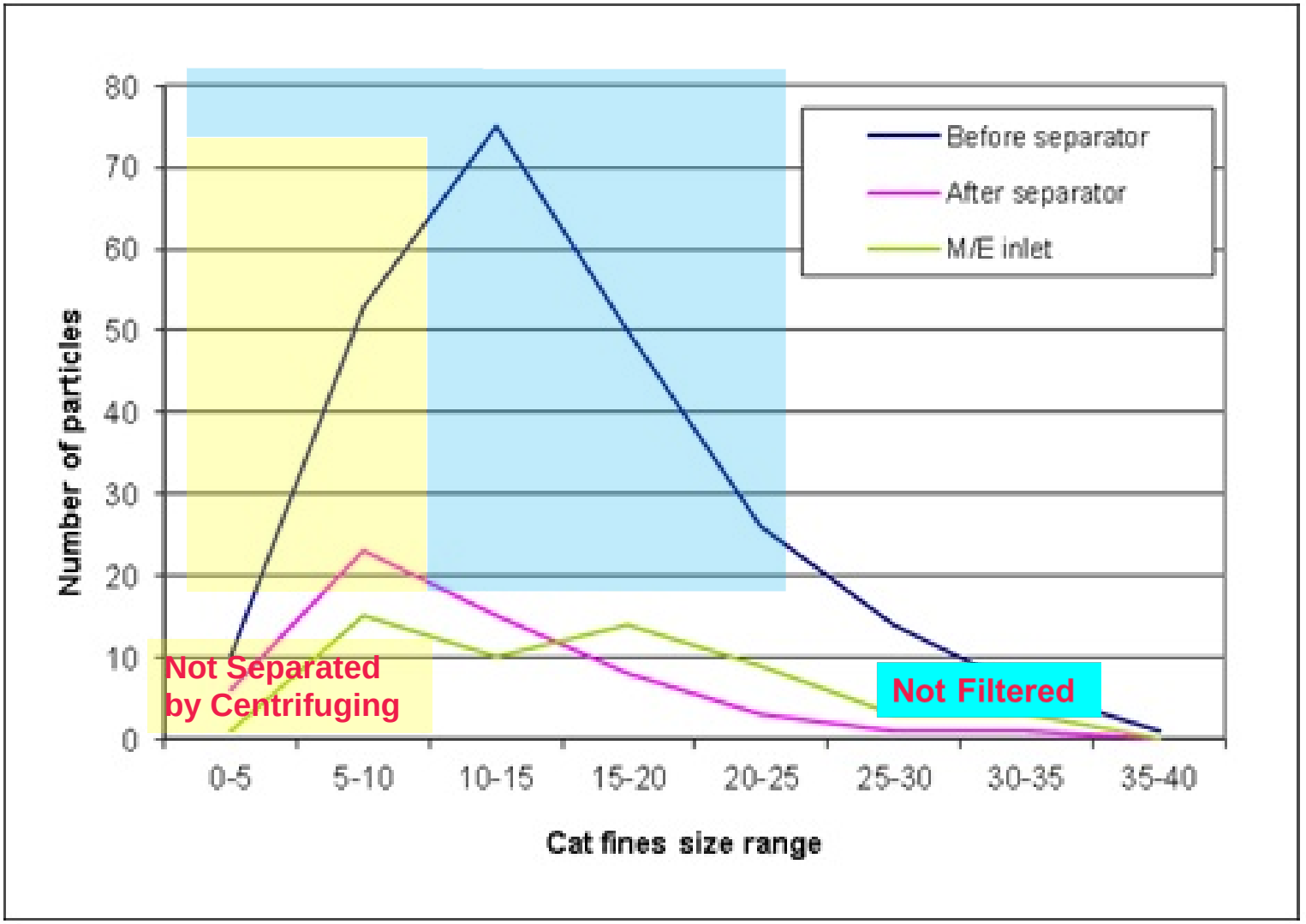
Size Matters

Typical particle size distribution by percent count

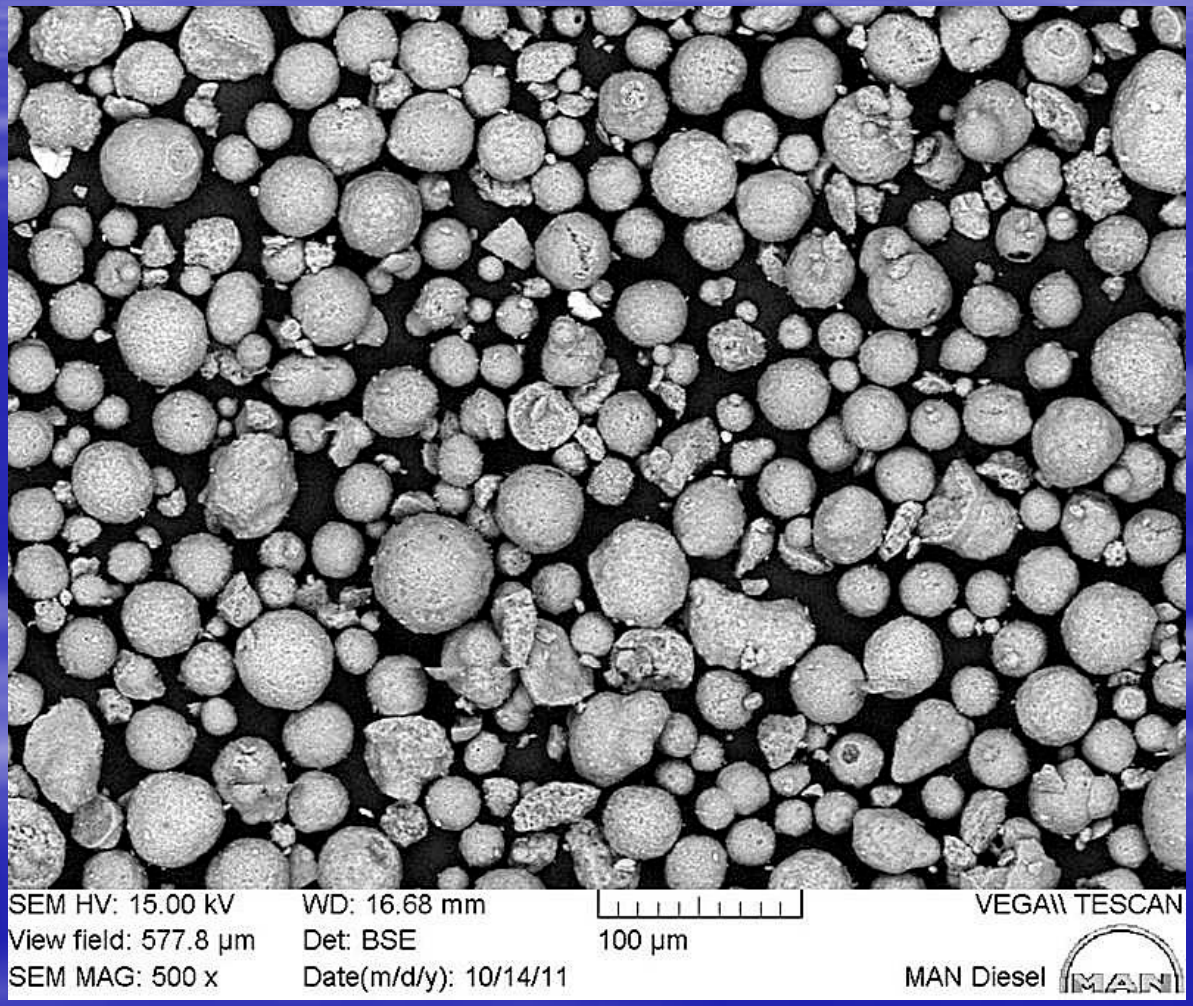
Size [µm]	Count [%]
1-5	30
6-15	55
16-25	10
26-50	5
>50	<0.3

The majority of cat fines fall between 5 to 15 µm in size.
Thickness of the oil film on liner walls may vary between 0.5 and 8 µm, which means that larger CF protrude through the oil film allowing metal-to-metal contact, quickly wearing both piston ring and liner wall

CF Distribution Diagram



How CF look like

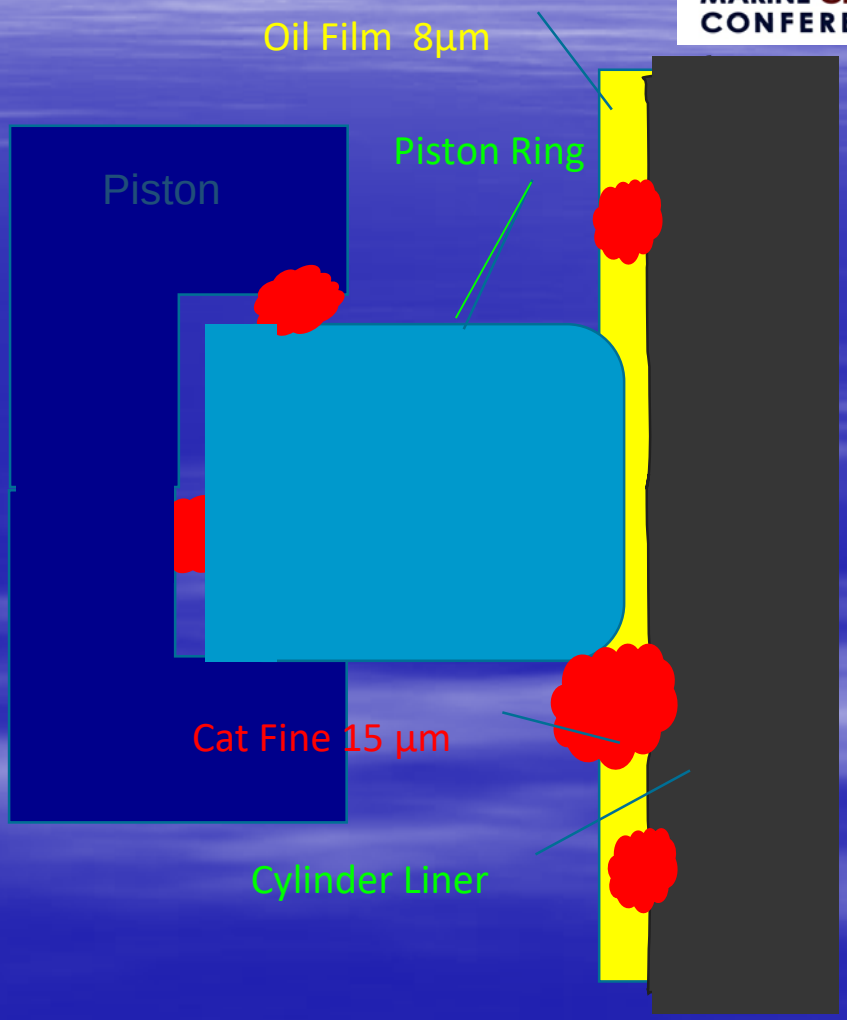


Wear Mechanism

Not to scale

When the engine is running, CF from the fuel are trapped between piston ring and groove or piston ring and liner causing wear to these components.

In severe cases in a very short period of time, even only in few tens of hours of operation



Consequences

- Accelerated wear in cylinder liners
- Breakage of piston rings
- Scuffing of piston crowns and piston skirts
- Fuel pump wear – Injection valve wear
- Blow-by of combustion gas
- Wear of stuffing box lamellas and piston rods
- Contamination of lubricating oil / damage to bearings
- Scavenge fires / Exhaust gas manifold fires
- Turbocharger damage by piston ring fragments
- Main engine stopping for insufficient pressure in combustion chambers

Piston crown with broken piston rings

Cracked cylinder liner

T/C blades destroyed by piston ring fragments

Some statistics by MAN-B&W

- Less than 200 CF per square cm (CF/cm^2) embedded onto the liner wall are almost harmless.
- More than 200 CF/cm^2 will increase wear rate.
- Over 1,000 CF/cm^2, will cause rapid destructive wear of liners and piston rings.
- On 60% out of 226 cases studied, CF exceeded 200 CF/cm^2, averaging 1,400 CF/cm^2

Facts

- Only rarely CF damage is associated to off-spec fuels, i.e. AL+Si > 60ppm
- CF entering the engine progressively build up on cylinder liner walls, piston grooves and piston rings
- CF settle at the bottom of tanks and may be stirred up in rough weather, mixing in a quantity above the capacity of separation and filtration, thus entering the engine in high concentrations

Why CF damage persists?

- Optimal efficiency of FO purifiers is 85% at fuel temperature 98 °C

- Purification at lower temperatures severely deteriorates the separation process.
  - FO heaters undersize (design)
  - Insufficient steam production (design/operation)
  - FO heaters clogged (operation)

- Efficiency of purifiers on board ships, unless constantly monitored and adjusted, may be below 70%.

CF removal twart

- Effective removal of catalyst fines by a fully efficient separator, is often lower than the nominal efficiency, maybe 70%÷75%.
- Centrifuges are capable of separating particles larger than 10 µm, therefore a large amount of smaller particles will elude the process.
- All new engines are fitted with a 34÷25 µm abs. filter, letting smaller particles pass through.
- A smaller mesh would clog too frequently.

Conclusions

- The current technology installed on board the majority of ships is inadequate to eradicate the problem of excessive amount of CF.
- The demand for cleaner fuels has left the shipowners in the middle of two conflicting conditions between fuel distillation and engine manufacturers' requirements without adequate means of complying to them.
- CF cannot be reduced to a level that would not affect a two-stroke engine
- Ill consequences may be contained, delayed and severity of damage may vary depending on circumstances, but damage cannot be averted

Your Views, Please!

IMCC
INTERNATIONAL MARINE CLAIMS CONFERENCE

.....on cat fines.

Thank you.