Heavy Fuel Oil for Marine Engines - Fuel Additive option for Quality Improvement

Suresh Shenoi
Vinay Kumar
Contents

- Introduction
- Bunker Fuel Standards
- Engine Operational Problems
- Deficiencies in Fuel Quality
- Trials in India
- Conclusion
Introduction

- Environmental Regulations – Demand for quality Improvement.

- Large Investment in Refineries

- Long Time Frame – 20 to 30 years

- Implied Increase in cost of marine fuels
Bunker Fuel Standards

- ISO 8217
- Deficiencies
  - Fuel Stability
  - Ignition Quality
- Injector Cleanliness
Operational Problems

- Fuel Instability
  - Sludge
  - Filter Choking
  - Rack Jamming
  - Erratic viscosity control
  - Impact on fuel atomisation

- Test Methods
  - Hot Filtration Test
  - Shell P Value
  - ROFA S Value
  - Turbiscan
Exhaust Valve/Turbocharger Deposits

- Generally Reported - Study CIMAC India

- Causes
  - Ignition Quality
    - CCAI
    - FIA IP 541/06
  - Impact of poor ignition quality
  - Study – Mr. Taheda, Nippon Yuko
  - No correlation between CCAI and FIA results.

- CCAI > 845, dispersion of ignition delay large
• Investigated relationship between FIA CN and combustion problems
• In all cases of fuel related engine problems, FIA CN was low.

• Recommended criterion for ignition quality - 20 FIA CN minimum
Solutions Recommended – Mr. Taheda

- Adjust Injection Timing
- Add Cetane Improver
  - 2 to 3 Points Improvement.

- Blend with Good Fuel – Stabilise with dispersant additive
- Quality Assurance Programme - Oil Major
  - Stability
  - FIA

- Cetane Improver - To Address Fuel Ignition Quality
Injector Cleanliness

- Cracking Processes in Refining
- Unsaturated HC- Injector Fouling
- Standards in Diesel - XUD 9
- ¼ of all Injectors in marine engines changed earlier than recommended schedule – 4000 hours
NO$\textsubscript{x}$ & Soot Emission Reduction

- Finer Spray Orifices
- Higher Injection Pressure
- Higher Cetane Number

- Finer Orifices- More Prone to be affected by fouling
- Detergent/Dispersant for Injector Cleanliness
Requirements for Efficient Operation

- Stable/Homogeneous Fuel
  - Precise Viscosity Control
- Clean Injectors – Good atomisation
- Good Self Ignition Quality
- Complete Combustion

- Benefits:
  - Higher SFC, Reduced Deposits, Lower Maintenance, Lower Noise & Emissions
Multifunctional Additive Solution

• Deficiencies in fuel fuel quality clearly identified
• Negative impact of deficiencies on engine performance evident
• Fuel quality improvement at refinery level not feasible in short term
• Mixing of fuels from different sources unavoidable
• Engine operator has risk of using fuel not completely or optimally fit for engine
TOTAL EMDFA 401

• Product of TOTAL France
• Contains
  – Dispersant to stabilise fuel
  – Detergent dispersant to keep injectors clean
  – Cetane Improver to improve self ignition and smooth combustion quality of fuel
• “Ashless” - completely organic and combustible, no metallic constituents, as required by manufacturers

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Approach to evaluate performance

- No standardised engine test methods
- Research engine tests not feasible
- Tests in actual operating engines unavoidable
- Land based marine engines operating as base load power generating units - operate at consistent conditions
  - Evaluation and monitoring possible
  - Reasonable accuracy of data
Trials In India

- Dosage 400 ppm
  - Clean up 1000 ppm – 250 hours

-Methology
  - 250 hours - Without additive – Reference SFC
  - 250 hours - Clean up at 1000 ppm
  - 250 hours - Keep clean operation – 400 ppm

- Consistency of load.

- Unavoidable load fluctuations – exclude deviant data.

- Complete trial in 30/40 days – consistency in climate condition

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Engine Makes for Trials with EMDFA 401

- WARTSILA
- B & W MAN
- CATERPILLAR
- PIELSTICK
- SULZER
- NIGATA
- SKODA
SUMMARY OF PERFORMANCE TEST RESULTS ON LAND BASED MARINE ENGINES IN INDIA
Pasupati Fabrics Limited

- 3 X 2700 KVA CATERPILLAR
- PRE ADDITIVE 3.69 kwhr per litre
- POST ADDITIVE 3.77 kwhr per litre
- IMPROVEMENT 2.17 %
- REDUCED SLUDGE 26 % - 40 %
- NO INJECTOR DEPOSITS AFTER 4000 HRS OPERATION
- REDUCED EXHAUST VALUE & TURBOCHARGERS DEPOSITS
- DISCERNIBLE REDUCTION IN EMISSIONS
SHAMKEN SPINNERS LTD.

- 1 x 2700 KVA CATELPILLAR
- SERIOUS PROBLEM OF RACK JAMMING WHICH NECESSITATED EMERGENCY SHUTDOWN
- EMDFA 401 APPLICATION
  - RACK JAMMING PROBLEM ELIMINATED
  - 2 % SFC IMPROVEMENT
  - REDUCED SMOKE
• 8 ENGINES, TOTAL CAPACITY ~ 45 MW, SULZER, PIELSTICK
• SFC IMPROVEMENT - 1.9 % TO 2.4 % in different engines
• SIGNIFICANT REDUCTION IN MAINTENANCE COSTS & EFFORTS
  – MUCH CLEANER INJECTORS, ENHANCED INJECTOR LIFE
  – LOWER DEPOSITS ON
    • PISTON CROWN
    • EXHAUST VALVES
    • TURBO CHARGERS
• MAJOR OVERHAUL CYCLE ENHANCED FROM 8000 TO 12000 HOURS.
YKK INDIA PVT. LTD., BAWAL, HARYANA

• 1 X 2.5 MW, WARTSILA ENGINE
• SFC IMPROVEMENT 2 % PLUS
• OTHER CUSTOMER OBSERVATIONS
  – HEALTHIER ENGINE SOUND
  – LESS SMOKE AT START UP
  – CLEANER INJECTORS
  – CLEANER TURBOCHARGER
  – REDUCED FILTER CHOKING

• 12000 HOUR OVERHAUL REPORT
ASAHI GLASS INDIA LTD., BAWAL, HARYANA

- 2 X 3.6 MW, 1 X 1.8 MW, B& W MAN ENGINES
- SEPARATE TRIALS ON THE TWO 3.6 MW
- SFC IMPROVEMENT 2% PLUS IN BOTH CASES
- RACK JAMMING PROBLEM ON START UP ELIMINATED
- ENGINES UNDER O & M CONTRACT WITH POWERICA. POWERICA’S FEED BACK TO CUSTOMER HAS BEEN VERY POSITIVE
- INCREASED OVERHAUL PERIOD FROM 16000 HRS TO 18500 HRS

NEO PETCON INDIA PVT LTD
VVNL YELAHANKA, BANGALORE

- 6 × 20 mw Pielstick
  - Over 6% Improvement in SFC
  - Erratic viscosity control problem eliminated
  - Filter choking eliminated
  - Drastic smoke reduction
• Star Wire Industries Ltd 2.2 mw Pielstick  
  – Over 5% improvement in SFC
• Mangalam Cenents 5.5 mw Nigata  
  – 4% improvement in SFC
• Surya Roshni Ltd., Bahadurgarh 1450 kw Skoda  
  – 4.4% Improvement in SFC
• Jindal Industries Ltd., Hissar 2mw Pielstick  
  – 2.5% Improvement in SFC
  – Drastic reduction in engine deposits
• SPL Ltd., Bahadurgarh, 4.5 mw Sulzer  
  – 3% improvement in SFC
• Magnum Power, Manesar, 6.5mw Deutz  
  – over 3% improvement in SFC
Benefits

- SFC Improvement – at least 2%
- Longer Injector Life
- Longer life of exhaust valves & turbo charger components – drastic reduction in deposits
- Increase in periods between overhauls
  - Case 1 – 8000 hours to 12000 hours YKK Wartsila
  - Case 2 -16000 hours to 18500 hours Asahi B&W MAN
- Sludge reduction – from 1% to less than 0.5%
- No Filter Choking/Rack Jamming
- Less Noise/Emissions – Qualitatively observed
Issues During Trials

- Changes in Fuel Quality
- Climate Changes
- Instrument Errors - recalibration and retrial
Conclusion

- Deterioration of Fuel Quality Inevitable Reality
- Deficiencies Identified
- Impact on Engine Performance studied well

- Well Designed MFA optimum cost effective solution
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- Service Representatives of Engine Manufacturers
Thank You