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SYNTHETIC LUBRICANT CASE STUDY:- DISCUSSING PERFORMANCE BENEFITS COMPARED TO CONVENTIONAL OILS

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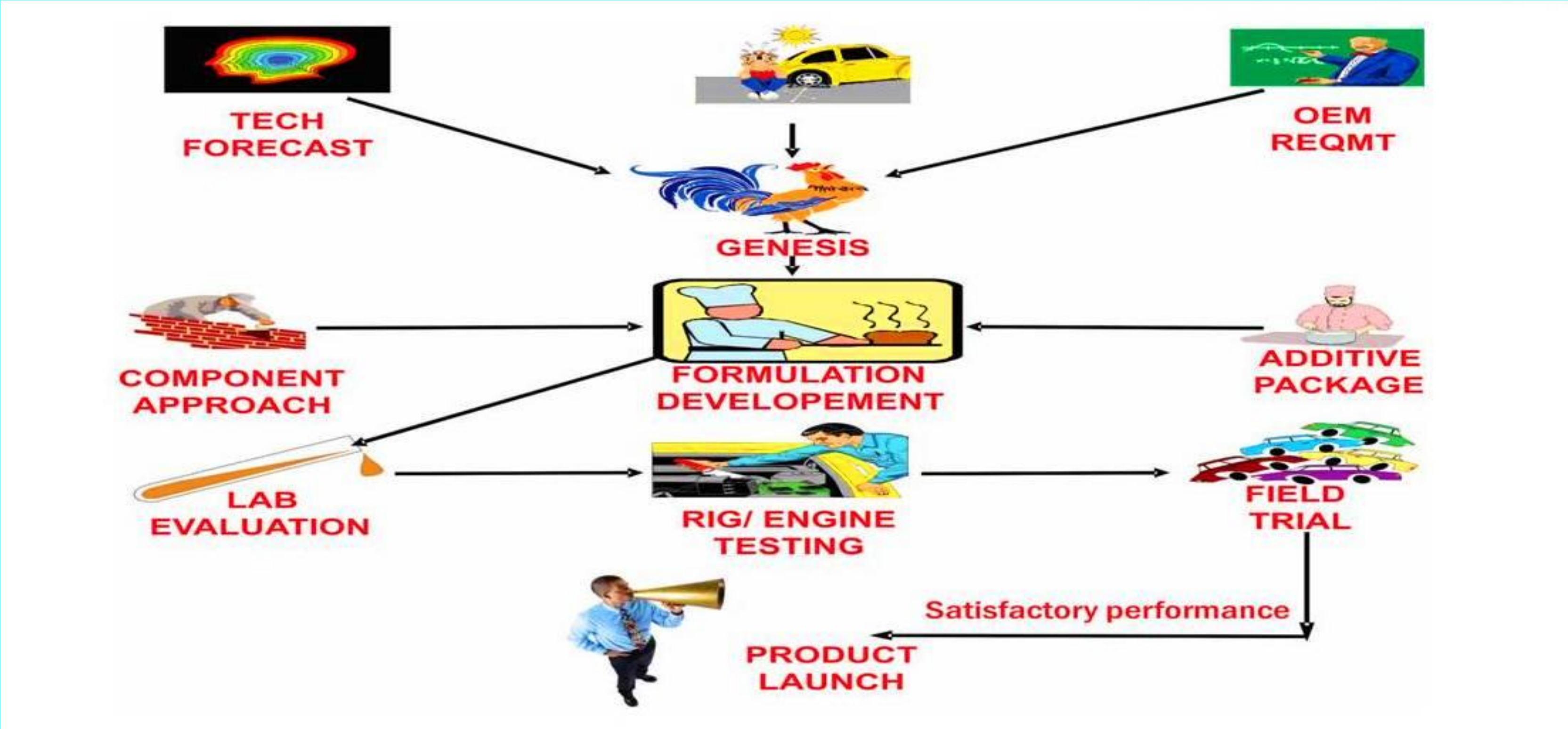
CONTENTS

- Importance of synthetic lubricants
- Categories of base fluids
- Special performance benefits of synthetic lubricants
- Field Studies on
  - Synthetic Compressor Lubricants
  - Heat Transfer Systems

SAGA OF LUBRICANT DEVELOPMENT



INTRODUCTION

- **Factors such as fill for life lubricant concept, stringent emission regulations, drive for fuel & lube efficiency, environmental concerns govern the lubricant trends.**

- **High performance lubricants based on non-conventional synthetic base stocks started replacing the conventional mineral oil based lubricants.**

❖ **REQUIREMENTS OF HIGH PERFORMANCE SYNTHETIC LUBRICANTS:**

- ***Very low volatility***
- ***Superior low temperature characteristics***
- ***Excellent oxidation resistance***
- **Special performance like hydrocarbon insolubility**

SYNTHETIC LUBRICANTS - WHY SUPERIOR

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- Based on synthetic base stocks made by chemical conversion of low-molecular weight components into compounds of controlled molecular structure with predictable properties.
- Because of tailor made molecules these provide superior performance over conventional mineral oil based lubricants

High purity and molecular size uniformity

BASE OIL CATEGORY

	BASE OIL CATEGORY	SULPHUR (%)	SATURATES	VISCOSITY INDEX
1.	GROUP I	. 0.03 % AND/OR	< 90	80-120
2.	GROUP II	< 0.03 AND	> 90	80-120
3.	GROUP III	< 0.03 AND	> 90	> 120
4.	GROUP IV	POLYALPHAOLEFINS (PAOs)		
5.	GROUP V	ALL OTHER BASE STOCKS NOT INCLUDED IN GROUP I,II,III OR IV - Polyglycols, Diesters & Polyol Esters, Phosphate esters etc.		

INDUSTRIAL OILS
ISO VG SYSTEM

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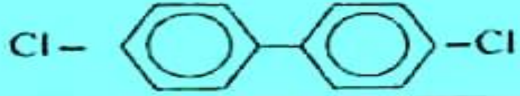
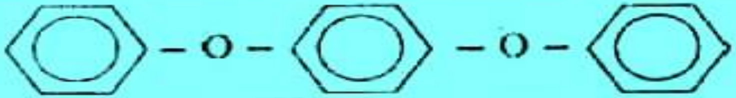
ISO VG viscosity grade	Midpoint viscosity cSt@40°C (104°F)	Kinematic viscosity limits cSt@40°C (104°F)	
10	10	9	11
15	15	13.5	16.5
22	22	19.8	24.2
32	32	28.8	35.2
46	46	41.4	50.6
68	68	61.2	74.8
100	100	90	110
150	150	135	165
220	220	198	242
320	320	288	352
460	460	414	506
680	680	612	748

SYNTHETIC LUBRICANTS

Class	Typical Structural Formula	Application
Alkylbenzenes		Refrigeration oil Heat Transfer Fluids
Polyalphaolefins	$CH_3 - \underset{C_8H_{17}}{CH} - CH_2 - \underset{C_8H_{17}}{CH} - CH_2 - \underset{C_8H_{17}}{CH_2}$	Engine oils, Gear oils, hydraulic oils
Polybutene	$(- CH_2 - CH_2 - CH_2 - CH2)_n$	Air compressor oils, 2T oils
Diesters	$R - O - \overset{O}{\overset{\parallel}{C}} (CH_2)_n - \overset{O}{\overset{\parallel}{C}} - O - R$	Gas turbine oils, Hydraulic oils, Compressor oils,
Polyolesters	$C(CH_2 - O - \overset{O}{\overset{\parallel}{C}} - R)_4$	Jet Engine oils
Phosphate Esters	$R - O - \underset{R'}{\overset{O}{\overset{\parallel}{P}}} - O - R''$	Fire resistant hydraulic fluids

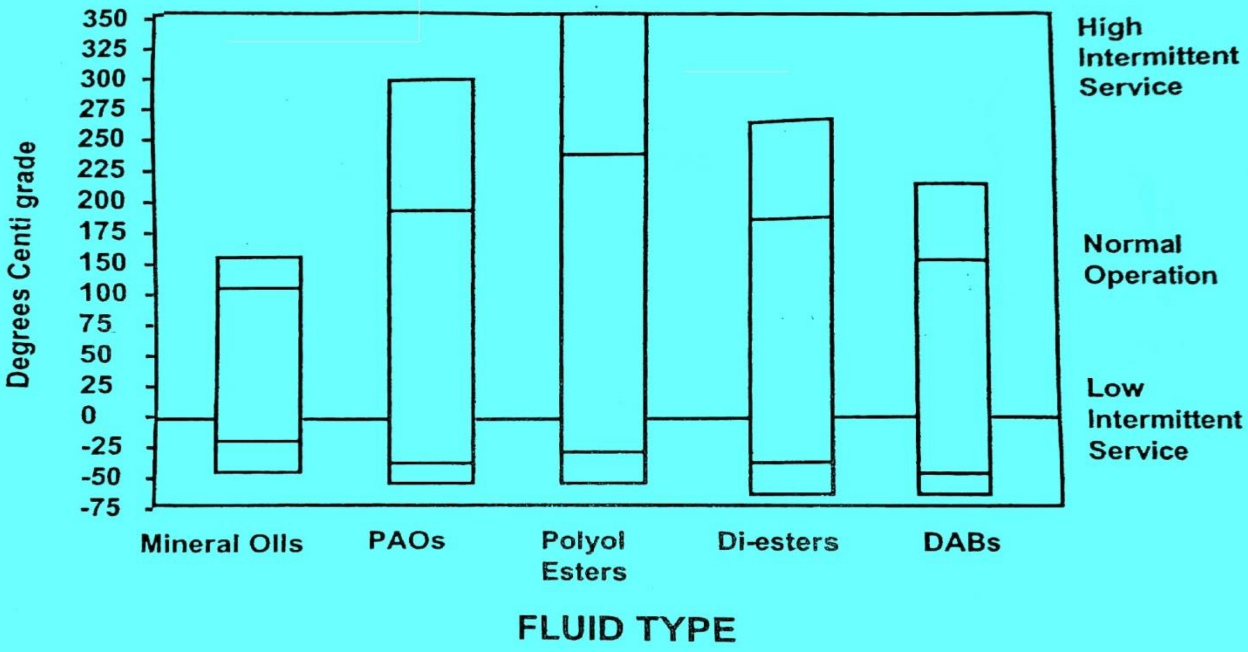
SYNTHETIC LUBRICANTS

Polyalkyleneglycols	$RO\left[-CH_2-\underset{}{\overset{R'}{CH}}-O-\right]_n R''$	Gas compressor oils, gear oils, W/G fluids
Silicone	$\left[-\underset{R1}{\overset{R}{Si}}-O-\right]_n$	Greases, Brake fluids
Silicate Ester	$Si-(O-R)_4$	Heat Transfer Oil, electronic coolant, low temperature greases
Chlorofluorocarbons	$\left[-\underset{F}{\overset{Cl}{C}}-\underset{F}{\overset{F}{C}}-\right]_n$	Oxygen compressor oil
Chlorinated diphenyls		Transformer Oils
Polyphenylether		Heat transfer fluids

PAOs are the largest synthetic group, followed by esters and PAGs.

Overall advantages of synthetics as a class.

MINERAL OIL VS. SYNTHETIC LUBRICANTS OPERATING TEMPRATURE COMPARISON



Synthetic- Performance Advantages

- Low operating costs and improved performance

- Extended drain intervals Vs. mineral oils by improving
  - Oxidation resistance and thermal stability
  - Uniformity of base oil composition, narrow MW distribution which eliminates lower ends
  - Reduced volatility
- Longer equipment life and lower downtime
  - Improved film thickness, better inherent lubricity, reduced wear and pitting
  - Lower operating temperatures
  - Lubricate under extreme conditions
  - Good solvency and low varnish leading to lower filter clog

BIODEGRADABILITY OF SOME LUBRICANTS

LUBRICANT	BIODEGRADABILITY, %
Mineral Oils	15-35
White Oils (highly refined mineral oil)	25-45
Vegetable Lubricants	70-100
Polyalphaoleins (PAO)	5-30
Polyethers	0-25
Polyisobutylenes(PIB)	0-25
Phthalate & Trimellitate Esters	5-80
Polyol esters & Diesters	53-100

WHEN SHOULD SYNTHETICS BE USED?

- Very high operating temperatures
- Very low operating temperatures
- High unit loads
- Legislative / Specification Requirements
- Difficult, expensive lubricant changes

Industries using Synthetic Lubricants

- Power Generation
- Oil and Gas Collection / Distribution
- Petroleum and Chemical Plants
- Paper Industry / Forest Products
- Cement Plants & Quarries
- Steel Industry
- Mining
- Textile
- Food & Canning Plants

SYNTHETIC COMPRESSOR OIL
LABORATORY STUDIES
- FIELD EVALUATION

INDUSTRIAL COMPRESSOR OILS - FUTURE TRENDS

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- Market dom inated by Mineral Based Compressor Oils for both for Rotary / Reciprocating Compressor.
- More compact designs of Compressors, High discharge temperature, necessiated the use of Synthetics Replacing Mineral Oil Products.
- A Fully Synthetic Product Sync0- A was Developed using PAO'S & Esters doped with Advanced Additive Technology. The product was tested for its physical & chemical properties.
- Superior Performance Benefits of Synthetic Compressor Oils are:

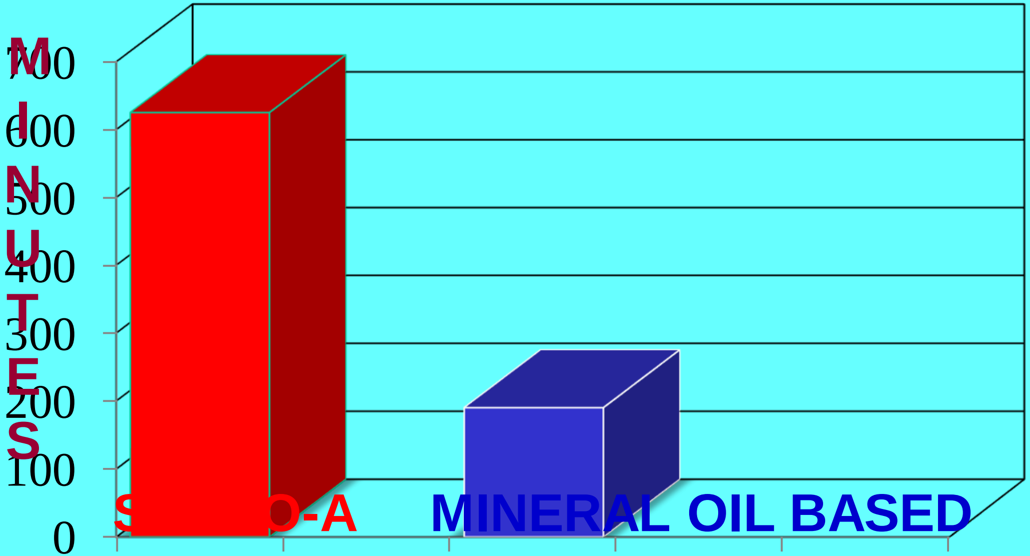
  -- Extended Oil Drain Intervals

  -- Reduced Carbon / Deposit Forming Tendency

  -- Reduced Emissions & Improved Energy Efficiency

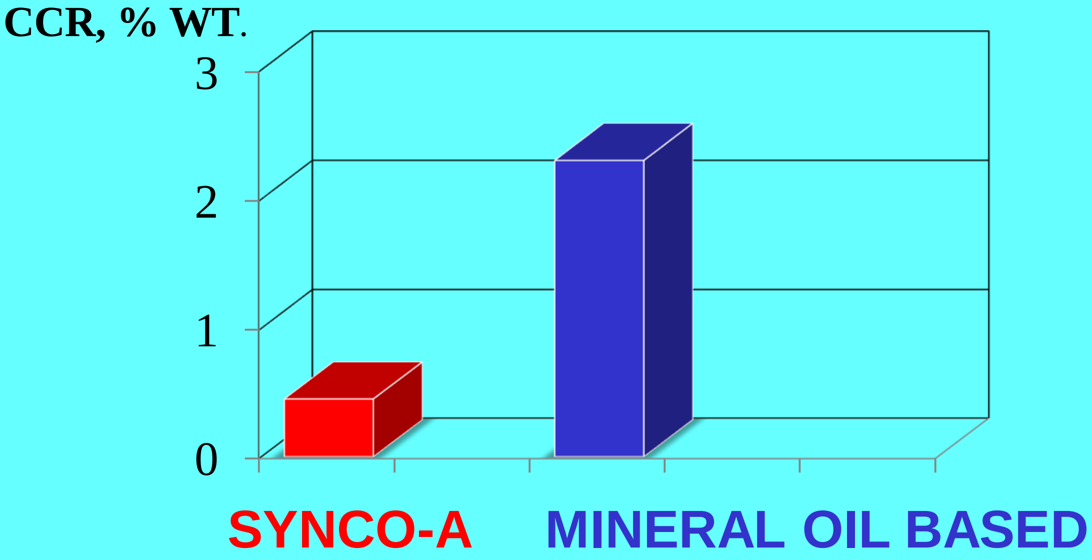
COMPARISON OF OXIDATION STABILITY

RBOT TEST, ASTM D-2272



HIGHER THE OXIDATION LIFE, LONGER THE OIL DRAIN INTERVAL

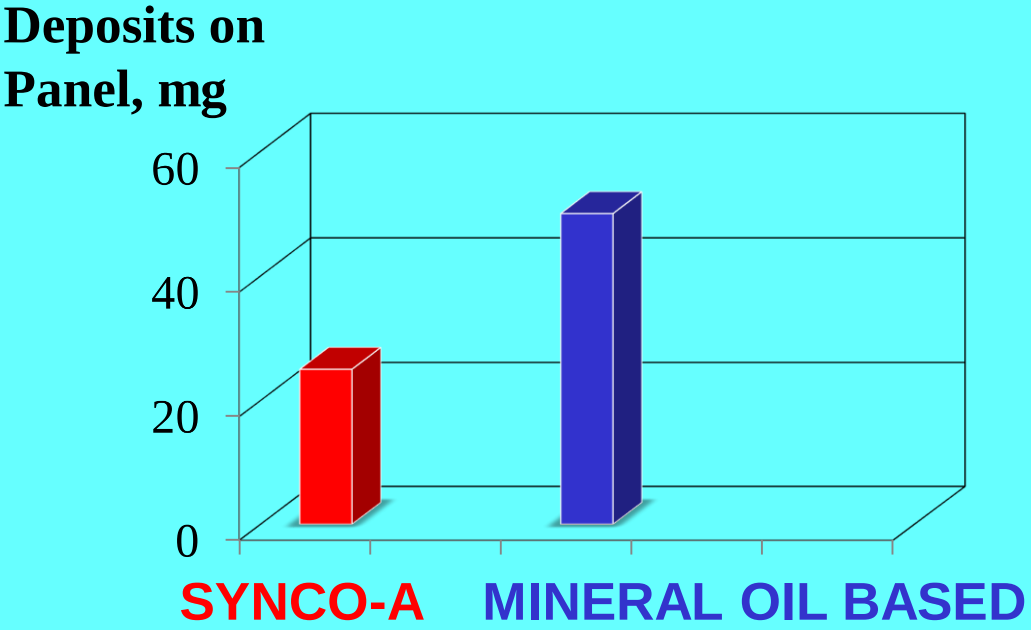
COMPARISON OF CARBON FORMING TENDENCY



LOWER THE CARBON FORMING TENDENCY , LOWER EXHAUST PORT BLOCKAGE

COMPARISON OF DEPOSIT FORMING TENDENCY

PANEL COKER TEST AT TEMP.@250°C , 6 Hrs



LOWER THE DEPOSIT BETTER THE OIL

TRIBOLOGICAL CHARACTERISTICS

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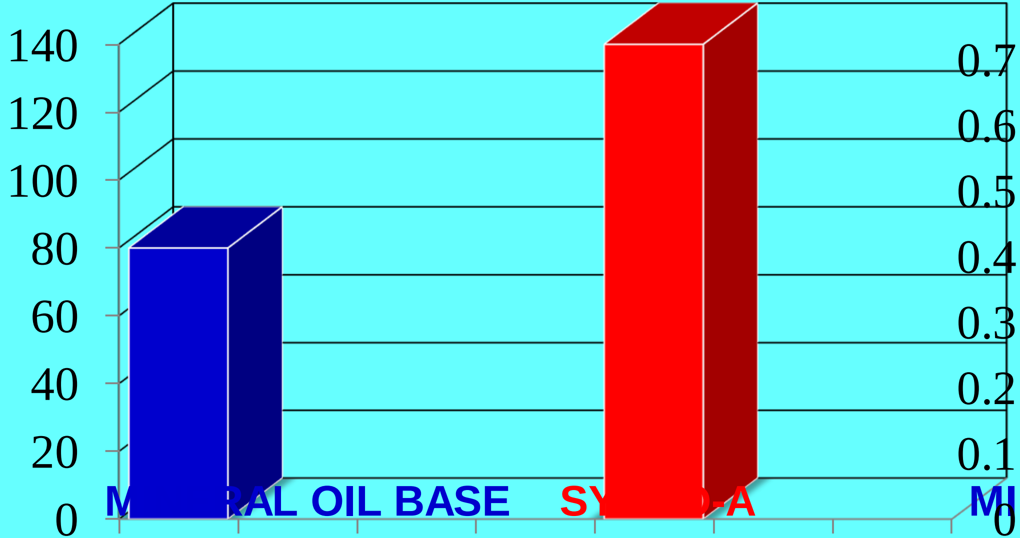
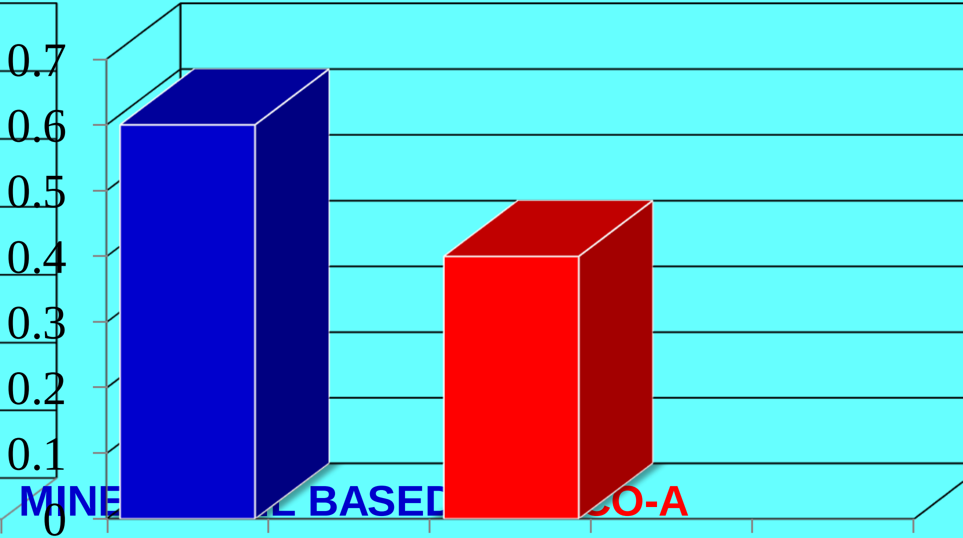
WELD LOAD, Kgs, (IP-239)



WSD, mm, (D-4172)



SUMMARY OF LAB EVALUATION:

SYNCO-A SHOWED REDUCED CARBON DEPOSITS, IMPROVED OXIDATION LIFE AND SUPERIOR TRIBOLOGICAL PERFORMANCE

FIELD TRIALS ON SYNCO-A

Compressor Type	Single Stage Oil Injected (Elgi)
Motor	50 HP, 415V, 3 Phase
Motor Speed	2960 rpm
Cooling	Air/Oil Cooled
Oil Capacity	32.0 Liters
Air Delivery Pressure	Minimum 70 psi(5bar)
Free Air Delivery	194 cfm at 7 bar
Oil Temperature	80-150°C

CONDITION MONITORING DATA

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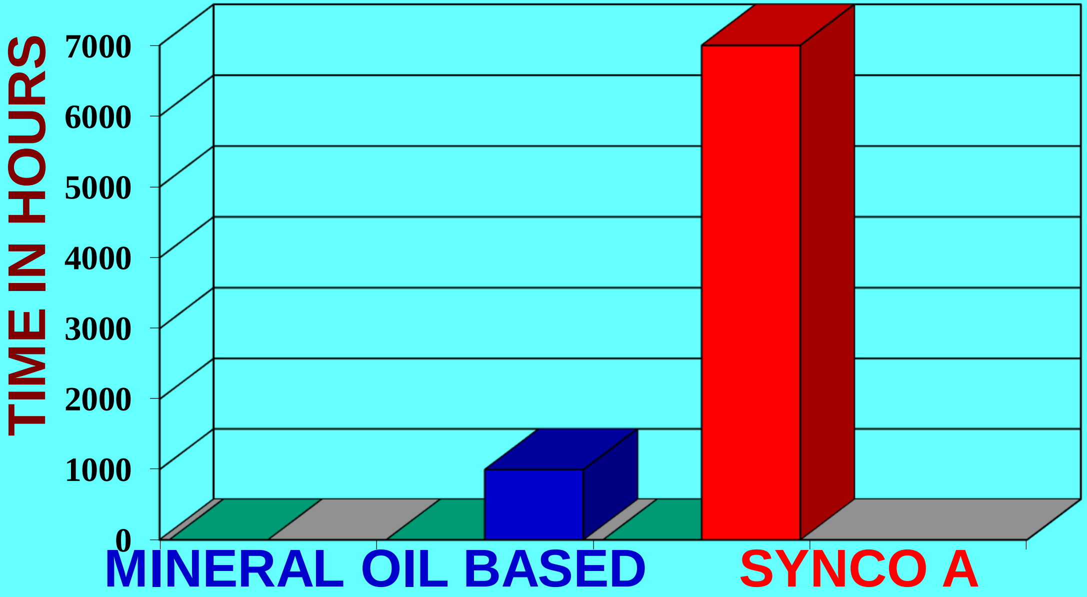
Time hours	Viscosity at 40°c cSt	TAN mgKOH/g	Sludge % wt	Colour ASTM 1500	Wear metals Fe, Cu, Sn, Pb(ppm)
0	**42.8**	**0.07**	**-**	**0.5**	**NIL**
519	46.55	0.34	0.09	3.0	NIL
1011	43.0	0.26	0.09	4.0	NIL
2005	43.34	0.28	0.12	4.5	NIL
3076	43.46	0.20	0.08	6.5	NIL
4064	43.70	0.26	0.06	7.0	NIL
6521	44.30	0.28	0.08	7.0	NIL
7002	44.20	0.30	0.08	7.0	NIL

FIELD EVALUATION : OIL SERVICE LIFE



- SEVEN FOLD INCREASE IN OIL SERVICE LIFE
- REDUCED DOWNTIME / OIL CONSERVATION
- REDUCED MAINTENANCE COST

HEAT TRANSFER SYSTEM

In Engineering & particularly in Chemical & process engineering , large quantities of heat have to be transferred at elevated operating temperatures for the smooth running of the system. Heat transfer fluids are used to do the specific jobs.

Two types of heat transfer fluids are encountered

1) Mineral oils
2) Synthetic oils

Mineral oils are generally recommenced for a bulk oil temperature of 300°C beyond which they undergo oxidation & thermal cracking.

Synthetic fluids offers the advantages of high boiling points, low vapor pressure, high auto ignition temperature, high thermal conductivity besides improved oxidation / thermal stability. These fluids are recommended up to a bulk oil temperature of 400°C

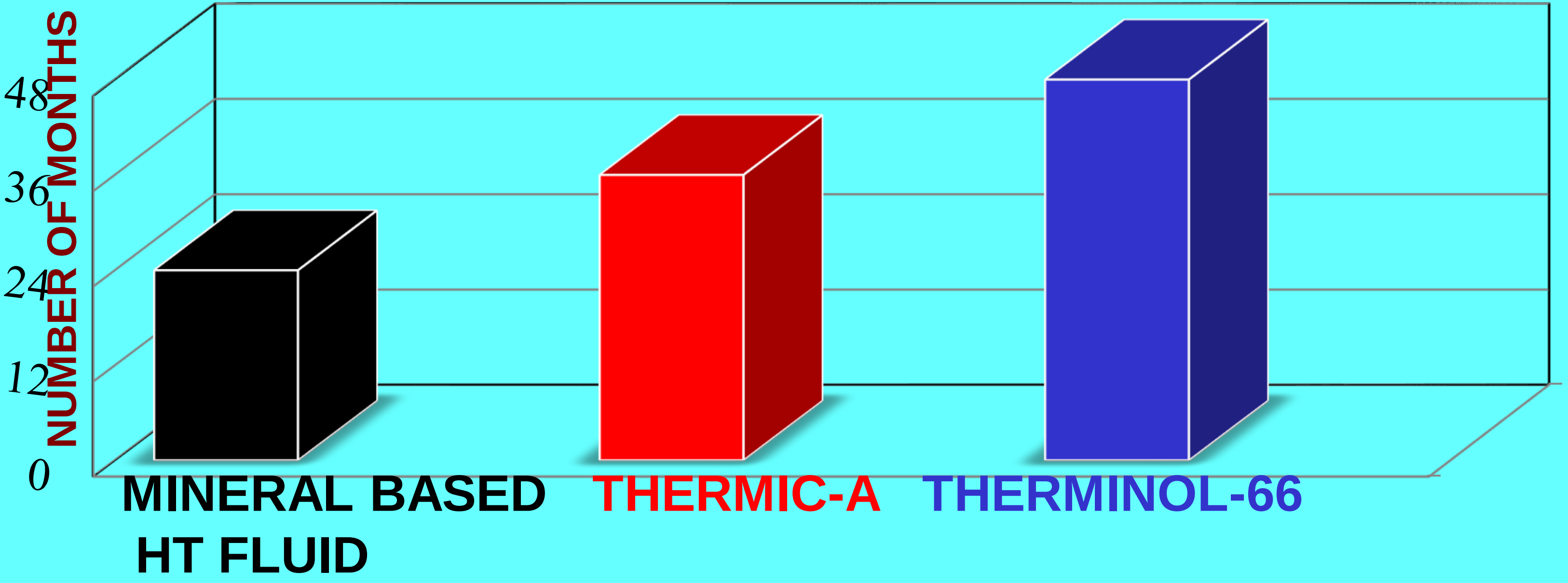
SYNTHETIC HEAT TRANSFER FLUID DEVELOPMENT

- A Cost effective Fluid Thermic-A based on Heavy alkylated benzenes (HABs) was developed using a combination of aminic & phenolic additives.
- Product evaluated for Heat capacity, Thermal conductivity, flash pt, Autoignition temperature besides other normal properties
- Field tested in a Blending plant in India along with an established expensive Synthetic oil Therminol 66 & a mineral oil based product.
- The maximum temperature attained in the plant was 330°C

REGULAR CONDITION MONITORING OF THE PRODUCT

- Kin Viscosity at 40°C
- TAN mgKOH/g
- Flash point °C
- Autoignition temperature was done after every one month
- The test data indicated that the cost effective product Thermic-A is quite comparable in performance with an expensive product Therminol-66, however it showed much improved performance over mineral oil based product.

Field Studies :- Oil Service Life



EXECUTIVE SUMMARY

- Synthetic Lubricants are used today in critical areas of applications where their increased cost can be offset by either their technical performance or by longer fluid life.
- Various classes of synthetic lubricants along with their chemistry & performance benefits over mineral oils are described.
- Field studies conducted on synthetic compressor oil & heat transfer fluid clearly indicates their superiority over mineral based products.
- A new class of combination of hydro cracked base oils along with parts synthetics ie. semi synthetic can be a good cost effective choice to meet Energy Savings / Fuel economy benefits, Global Emission requirements & Long life lubricants.

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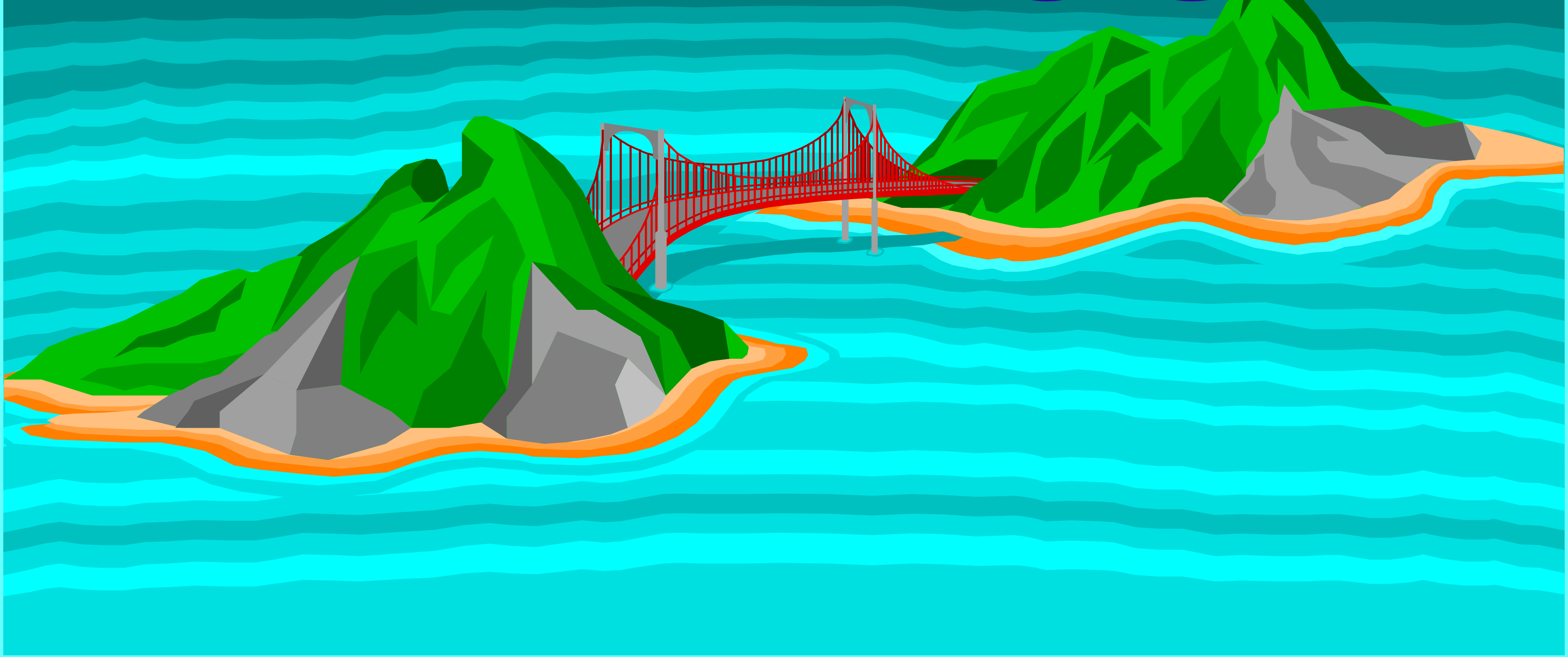
THANK YOU



HOW TO CHOOSE A LUBRICANT WITH A GOOD PERFORMANCE

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- Adequate Viscosity. / VI
- High Level Of Oxidation Stability
- Thermal Stability
- Good Demulsibility
- Low Volatility
- Good Level Of Detergency
- Foaming Characterstics

Synthetic Lubricants-Features

- **Wide formulation choice of base oils provide ability to derive best possible performance**

  - PAOs : Mineral oil like with better low temperature & oxidation stability, VI > 135
  - Polyglycols : Water soluble and water insoluble grades with VI > 200, very high load carrying ability
  - Silicones : Very high VI, High temperature applications
  - Esters : Excellent lubricity , low temperature performance and oxidation stability
  - Phosphate Esters : High fire resistance, used for high temperature applications

Synthetic Lubricants-Features

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- **Extended lubricant life vs. mineral oils in demanding applications**

  - High VI and shear stability
  - Solve problems where mineral oils can not , HFC refrigeration requires polyol esters
  - Ability to deliver environmental friendly products
    : Polyol Esters for biodegradable lubricants
  - Applications for Food Grade Lubricants : PAOs, Polyglycols and Polybutenes suitable for food processing lubricants