# SYNTHETIC HEAT TRANSFER FLUID-SERVOTHERM S SPECIAL

## INTRODUCTION:

Heat transfer phenomena is one of the most important and requisite step in industrial processing for indirect heating. Heat transfer media are materials used in industrial processes to transfer heat. In engineering and particularly in chemical and process engineering large quantity of heat has to be transferred at elevated operating temperature. Thermal fluid heating is a type of indirect heating in which a liquid phase heat transfer medium is heated and circulated to one or more heat energy users within a closed loop system. In these cases, high boiling heat transfer media are recommended. HTF are thermally stable fluids used for indirect heating and cooling from -100 ° C to 400 °C as circulatory media in hot oil systems. Different types of heat transfer fluids are used in industrial processes for transfer heat depending upon their operating temperature range.

## Requirements of Heat transfer fluid (HTF)

A heat transfer fluid must possess the following characteristics:

- **Low viscosity –**Lower the kinematic viscosity of the heat transfer fluid faster the heat transfer.
- **Excellent thermal stability** In the operating range
- **High flash / fire point**
- **Low pour point**
- **High specific heat and thermal conductivity**
- **High resistance to oxidation**
- **High boiling point & low vapor pressure over the operating temperature range**
- **Broad fluid range applicability**
- **Low sludge formation and good solvency**
- **Non-toxic & odourless nature**

Selection of HTF depends on various factors:

- ✓ **Operating temperature range**
- ✓ **Heat transfer properties**
- ✓ **Operating pressure**
- ✓ **Ease of operation**
- ✓ **Thermal stability**
- ✓ **Cost**

- ❖ Thermal stability of HTF has direct bearing with fluid chemistry, operating temperature and duration of exposure.
- ❖ Degradation of heat transfer fluids usually produces

  **Low boilers : vented from the systems**

  **High boilers : remain in the fluid & their concentration determines the useful life of the fluid.**

Today market is dominated by mineral oils and synthetic fluids. Mineral oil based heat transfer fluids are polynary mixtures consisting of paraffins or naphthenes based hydrocarbons, depending on origin. Mineral oils are generally recommended for a bulk oil temperature of 300°C beyond which they undergo oxidation and thermal cracking. Oxidation results in build up of organic acids and the formation of insoluble materials or sludge, which causes the fluid viscosity to increase. Further the sludge is deposited on the heat transfer surfaces thereby reducing the rate of heat transfer.

Synthetic fluids are manufactured by petrochemical and chemical companies and consist primarily (with some exceptions) of components with an aromatic structure as the nucleus. Due to their molecular structure and the strength of bonds between the atoms with the resultant high thermal stability, aromatic hydrocarbons are the most favorable class, Synthetic fluids offer the advantages of high boiling points, low vapor pressure, high auto ignition temperature, high thermal conductivity besides improved thermal/oxidation stability.

## PRODUCT DESCRIPTION

Servotherm-S Special is moderate viscosity alkyl aromatic type synthetic heat transfer fluid. The fluids capable of providing satisfactory service life in closed hot oil systems upto a bulk oil temperature of 320°C. Servotherm S Special is recommended as a fluid medium in various types of heat transfer system for indirect or secondary heating in industry. The use of this oil provides rapid heating and greater flexibility in heat transfer systems since it possess high specific heat and better thermal conductivity at all temperatures.(Fig 1 &2)

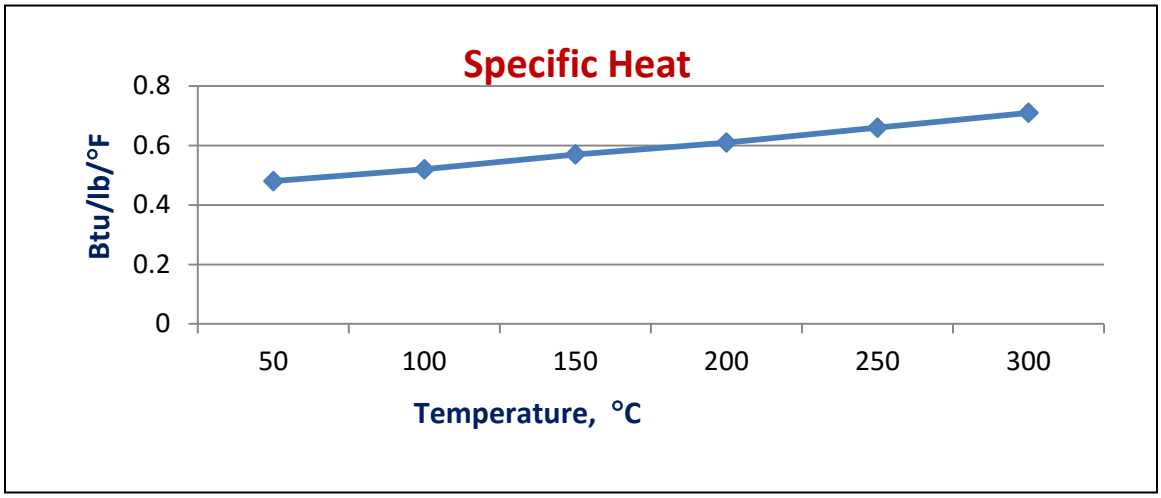
This oil is suitable for use in both, closed as well as open type heat transfer systems. This oil has a high resistance to thermal cracking and hence maintain their heat transfer efficiency

even when subjected to repeated high and low temperature cycles.

**KEY BENEFITS:**

Servotherm S Special offers the following advantages over conventional mineral fluids:

- ✓ Resist deterioration at the recommended temperatures to assure long fluid life and clean systems.
- ✓ Have low vapor pressures at operating temperatures to permit operation at atmospheric pressure.
- ✓ Possess good heat transfer characteristics.
- ✓ Low pour point and moderate viscosity with decreases the pumping losses and the power required for circulation.
- ✓ Excellent thermal and oxidation stability
- ✓ Low volatility
- ✓ Very low carbonaceous deposits and very good solvency



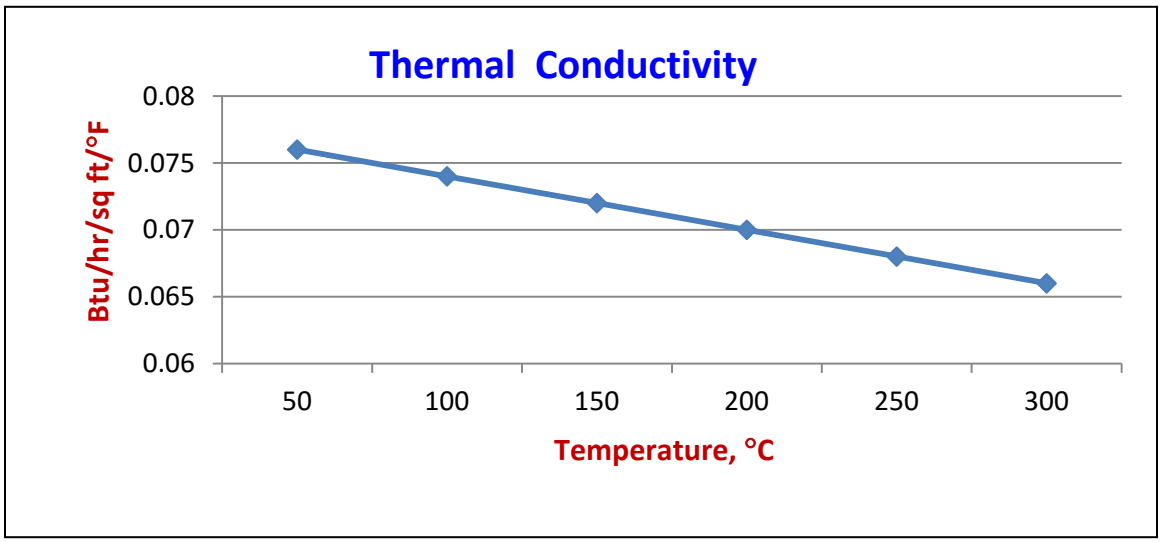



**Table 1: Typical Properties of Synthetic heat transfer fluid Servotherm-S Special**

| S.No. | Properties | Method | Servotherm-S Special |
|---|---|---|---|
| 1. | Appearance | Visual | Clear & Bright |
| 2. | Kinematic viscosity @ 40°C, cSt | D-445 | 18.99 |
| 3. | Kinematic viscosity @ 100°C, cSt | D-445 | 3.88 |
| 4. | Viscosity Index | D-2270 | 81 |
| 5. | Density @ 15°C | D-4052 | 0.8652 |
| 6. | Total acid no. mgKOH/gm | D-974 | 0.03 |
| 7. | Flash point, °C | D-92 | 208 |
| 8. | Fire point, °C | D-92 | 228 |
| 9. | Autoignition Temperature, °C | E-659 | 378 |
| 10. | Pour point, °C | D-97 | -57 |
| 11. | Copper Corrosion | D-130 | 1a |
| 12. | Boiling range, °C<br>IBP<br>10%<br>90%<br>FBP | D-86 | <br>310<br>345<br>393<br>400 |
| 13. | Ash. % | D-482 | 0.003 |
| 14. | CCR, % | D-189 | nil |
| 15. | Max. Film Temp. °C | | 345 |
| 16. | Coefficient of Thermal Expansion | - | 0.00039 |
| 17. | Vapour Pressure, mm<br>50 °C<br>100<br>150<br>200<br>250 | - | <br>$0.32x10^{-3}$<br>0.02<br>0.58<br>7<br>45 |

## PERFORMANCE EVALUATION

### HDPE Extruder System of Panipat Petrochemical Unit

HDPE Extruder heating system of Panipat Petrochemical unit has two hot oil systems with details as follows.

1. Tank I Capacity – 800 lts ,

Hot Oil Unit (1)

| Flow Rate [$m^3/h$] | Pump Discharge Press [m] | Operation Temp. [°C] | | Design | | Medium |
|---|---|---|---|---|---|---|
| | | Nor. | Max. | Press. | Temp. | |
| 20 | 78.5 | 100~200 | 250 | 14.7 kg/cm2G | 350°C | Marlotherm LH |

2. Tank II Capacity – 1600 lts ,

Hot Oil Unit (2)

| Circuit | Flow Rate [$m^3/h$] | Pump Discharge Press [m] | Operation Temp. [℃] | | Design | |
|---|---|---|---|---|---|---|
| | | | Nor. | Max. | Press. | Temp. |
| Zone 1 for GP& SC | 65 | 65 | 220~260 | 280 | 14.7 $kg/cm^2G$ | 350℃ |
| Zone 2 for Die plate | 65 | 65 | 220~260 | 280 | 14.7 $kg/cm^2G$ | 350℃ |

The Hot oil unit tank pressure for both units are 0.7 to 1.2 $kg/cm^2$. As per hot oil system, there are two tanks and oil requirement is Specific gravity 0.78-1.0, Oil Viscosity 0.3 cps to 7.6 cps and oil operating temperature 220-260 with heater cut off at 280 degree cent.

In this heating system Hot oil of brand name Marlotherm LH is being used as recommended by the vendor M/s Kobelco,Japan. Marlotherm LH is synthetic heat transfer fluid based on mono benzyl toluene.

Servotherm S Special replaced imported Marlotherm LH in two hot oil systems (Kobelco Japan) of HDPE Extruder Unit of PNCP Panipat system (Operating temp. 265-285°C /365 days) in April, 2014. Sample is drawn every year from hot oil system for checking the health of the oil. The condition monitoring data is given in Table 2 & Fig 1. It is evident from data and figure that there is no significant change in viscosity and acid no. with time indicating least generation of acidic components in such stringent conditions resulting practically no degradation of oil and supporting high oxidation and thermal stability of the oil ( Fig 2). The product is running smoothly from last four years and has given satisfactory performance. Field experience with this oil concluded long, trouble free service life of heat transfer Systems.

## Table 2 : Servotherm S Special : Trial data

| S.N | Properties | Test Method | Servotherm S Special Fresh | Servotherm S Special Used (8640 hrs) | Servotherm S Special Used (17280 hrs) | Servotherm S Special Used (25920 hrs) |
|---|---|---|---|---|---|---|
| 1 | Appearance | Visual | Clear & Bright | Clear & Bright | Clear & Bright | Clear & Bright |
| 2 | Kinematic Viscosity @ 40°C, cSt | D-445 | 17.52 | 15.37 | 16.14 | 17.25 |
| 3 | Kinematic Viscosity @100°C, cSt | D-445 | 3.59 | 3.42 | 3.53 | 3.54 |
| 4 | Density @ 15.6 °C | D-4052 | 0.8605 | 0.8488 | 0.8432 | 0.8455 |
| 5 | Flash Point, °C | D-92 | 208 | 190 | 183 | 180 |
| 6 | CCR, % | D-189 | 0.0 | 0.0 | 0.0 | 0.1 |

**Fig 1:Servotherm S Special : Acid Number vs. Time**

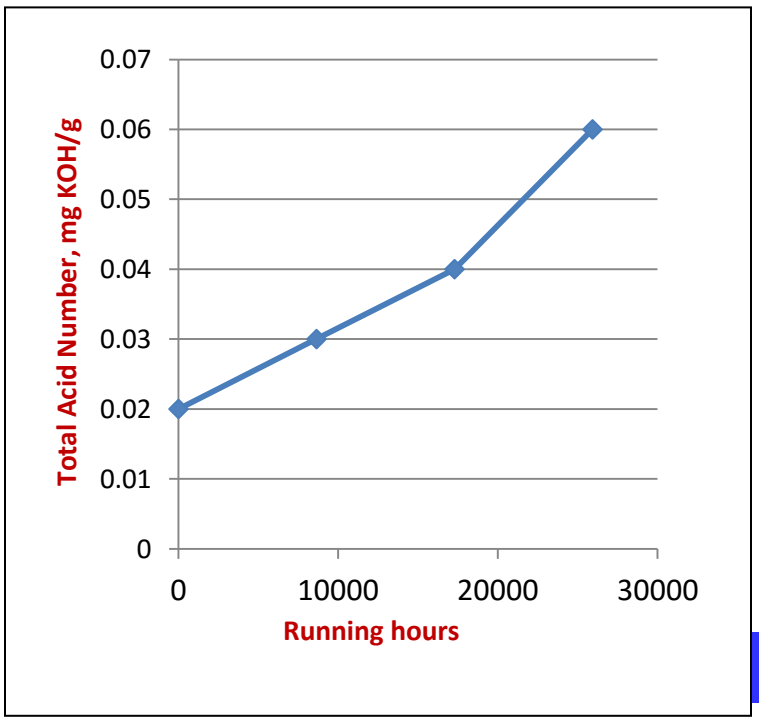
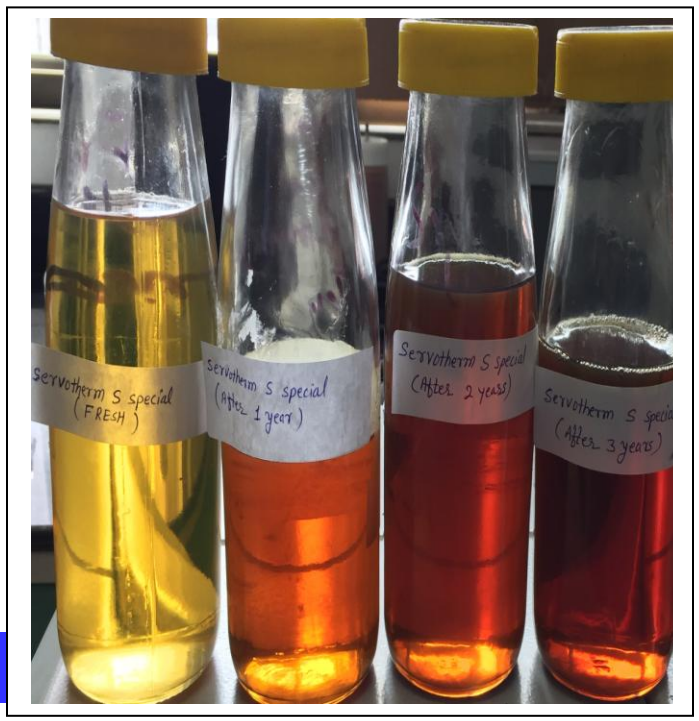



**Fig 2: Samples for Condition Monitoring**



## Compatibility of Servotherm S Special with other Heat Transfer Fluids

**Mineral oil base Heat Transfer Fluids** : Servotherm S Special is compatible with mineral oil ( paraffinic or naphthenic hydrocarbons) based heat transfer fluids such as Shell Thermia Oil A, Shell Thermia Oil B, Servotherm light, Servotherm medium, Servotherm super, Hytherm 500, Hytherm 600 etc.

**Synthetic oil based heat transfer fluid** : Servotherm S special is compatible with synthetic heat transfer fluids (alkyl Aromatic derivatives) for eq. Therminol 55, Marlotherm LH, Marlotherm SH, Hitech Therm 60, Hytherm S, Sigmatherm K

### Compatibility Test of Therminol 55 with Servotherm S Special

Sample of Therminol 55 was tested for physicochemical properties and test results are compiled in Table 3. The sample mixed with Servotherm S Special in 25:75, 50:50 and 75:25 ratios and tested for any separations at higher and lower temperatures. The test results are compiled in Table 4.

**Table 3: Properties of Therminol 55 and Servotherm S Special**

| S.No. | Properties | Therminol 55 Fresh | Servotherm S special Fresh |
|---|---|---|---|
| 1 | Appearance | Clear and Bright, yellow in color | Clear and bright |
| 2 | Kinematic Viscosity @ 40°C,cst | 20.26 | 18.99 |
| 3 | Kinematic Viscosity @ 100°C,cst | 3.70 | 3.88 |
| 4 | Viscosity Index | 38 | 81 |
| 5 | Total Acid Number, mgKOH/gm | 0.01 | 0.03 |
| 6 | Density @ 15°C | 0.8560 | 0.8652 |
| 7 | Flash point, °C | 193 | 208 |

**Table 4: Result of Homogeneity and Miscibility test of Therminol 55 (Th 55) and Servotherm S Special (STSS)**

| S No. | Characteristics | STSS : Th 55 25:75 | STSS : Th 55 50:50 | STSS : Th 55 75:25 |
|---|---|---|---|---|
| 1 | K. Viscosity @ 40°C | 19.91 | 19.50 | 19.12 |
| 2. | K. Viscosity @ 100°C | 3.70 | 3.70 | 3.69 |
| 3. | Initial sample | **No separation** | **No separation** | **No separation** |

| | | | | |
|---|---|---|---|---|
| 4. | Warmed to just above cloud point after having once reached pour point | **No separation** | **No separation** | **No separation** |
| 5. | After a cycle of heating to 230 °C cooling to pour point, storing for 24 hrs. at this temperature and warming to just above pour point | **No separation** | **No separation** | **No separation** |
| 6. | Warmed to room temperature | **No separation** | **No separation** | **No separation** |


## APPLICATIONS

Servotherm S Special is suitable for all types of heat transfer applications. This product finds extensive application in textile, pharmaceuticals, chemical and processing industries.

**RECOMMENDATIONS:**

- ✓ Servotherm S Special is synthetic heat transfer fluid suitable for use in closed hot oil system for temperature up to 320 °C. Under proper nitrogen blanketing this heat transfer fluid can perform well and resist thermal cracking over a period of time leading to long service life.
- ✓ Servotherm S Special is compatible with both mineral based and synthetic based heat transfer fluids.
- ✓ Servotherm S Special can be used for top up in hot oil system currently running with mineral oil based HTF with improved thermal properties and dissolution of sludge and deposits due to very good solvency.
- ✓ Usage of Servotherm S Special consumes less electricity for pumping than mineral oil based fluids having higher viscosity.