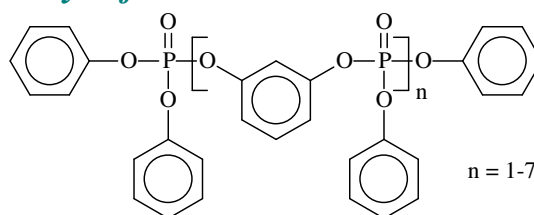


Fyrolflex[®] RDP Oligomeric bisphosphate

Application Data Sheet for PC/ABS alloys

Fyrolflex[®] RDP, an oligomeric bis-phosphate ester flame retardant, is designed for use in engineering resin applications. Chemical structure of **Fyrolflex[®] RDP** is shown below. Because of its low volatility and good thermal stability, this phosphorus flame retardant can tolerate high processing temperature required for many engineering resins. In addition to its high thermal stability, **Fyrolflex[®] RDP** demonstrates improved processing characteristics in a number of thermoplastics that benefit high resin flow in thin wall moldings and other high-performance applications. Table 1 shows typical properties of **Fyrolflex[®] RDP**.



CAS #: 57583-54-7

Table 1: Properties of *Fyrolflex[®] RDP*

| | |
|---|---|
| Physical appearance | Clear, transparent liquid |
| Phosphorus content, wt. % | 10.7 |
| Specific gravity, 25°C/25°C | 1.318 |
| Density @ 25°C, kg/m³ (lbs/gal) | 1.298 (10.83) |
| Viscosity @ 25°C, mPa s (@55°C) | 590 (105) |
| Acidity, mg KOH/g | 0.12 max |
| Water content, wt. % | 0.10 max |
| Color, APHA | 100 |
| Pour Point | -12°C (10°F) |
| Boiling Point | >300°C (>572°F) |
| Solubility (water) | Insoluble |
| Refractive index (@ 20°C) | 1.5773 |
| Latent heat of vaporization, Kcal/mole | 6.73 (calculated from vapor pressure data) |
| Thermal conductivity, cal/sec.cm² | 4.86 x 10⁻⁴ from 0°C to 50°C |
| Autoignition Temperature | >620 °C (1688°F) |

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Because of its relatively low viscosity *Fyrolflex*[®] RDP has the advantage over other liquid bis-phosphates. Low temperature of storage tanks and pumping lines allows energy saving and safer handling. In high temperature climate countries *Fyrolflex*[®] RDP can be handled without heating. Figure 1 shows dependence of viscosity of *Fyrolflex*[®] RDP on temperature. Based on the average ambient temperature and technical characteristics of metering pumps one can decide on the need of heating and temperature.

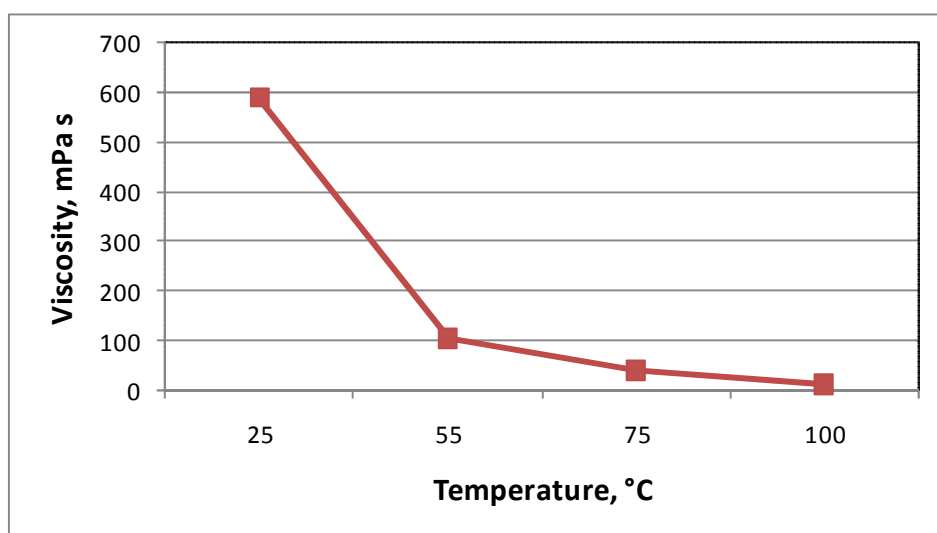


Figure 1: Viscosity of *Fyrolflex*[®] RDP at different temperatures.

□ Thermal stability

Thermo-gravimetric analysis of *Fyrolflex*[®] RDP (Table 2) reflects its good thermal stability permitting high processing temperatures typical for engineering thermoplastics.

| Table 2: Thermogravimetric analysis (TGA-10 ⁰ C/min in air) | |
|--|-----------------|
| Weight loss, % | Temperature, °C |
| 2 | 290 |
| 5 | 325 |
| 10 | 360 |

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□ Processing conditions and Properties

The following processing conditions are the one used on lab-scale equipment and given only as preliminary indications for guidance purpose only.

Compounding

Compounding of *Fyrolflex*[®] RDP into PC/ABS requires special but readily available equipment for liquid pump feeding. One common approach is to meter *Fyrolflex*[®] RDP into the mixer by use of a positive displacement feed system (gear pump injection for example) fitted with a pressure relief valve. In a typical operation, the solid components are fed into the mixer at a known rate using weight loss feeders and homogenized into a molten state. *Fyrolflex*[®] RDP is delivered at a downstream port to a non-compression area (such as a port situated just after a vent zone of an extrusion screw). Here the free volume of this screw section allows *Fyrolflex*[®] RDP to be easily pumped into the extruder and dispersed into the polymer matrix. To facilitate *Fyrolflex*[®] RDP, the system can be heat traced to improve the flow of *Fyrolflex*[®] RDP into the compounding apparatus (for reference see viscosity chart in Figure 1).

Fyrolflex[®] RDP functions as a processing-aid enabling lower temperatures to be used and has been shown to be easy to compound with PC/ABS alloys. Typical processing conditions to compound and mold PC/ABS alloys flame retarded with *Fyrolflex*[®] RDP are as follows:

Compounding in a co-rotating twin-screw extruder (L/D = 32)

Temperature profile, °C: 150-180-240-250-250-250-250-250

Screw speed, RPM: 370

Injection molding

Temperature profile, °C 245-245-250-255-260

Mold temperature, °C 70

Pressures, Bar Injection: 1200 - Holding: 800 - Back: 20

Cycle time, sec 16

Properties

Table 3 provides indicative formulations and comparative properties achievable in PC/ABS (80/20).

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Table 3: Properties of flame retarded PC/ABS alloys (80/20).

| Type | FR | Ref. no FR | <i>Fyrolflex</i> [®] <i>RDP</i> | TPP** |
|--|----|---------------|---|-------|
| <u>Composition, weight %</u> | | | | |
| PC/ABS (80/20) | | 100 | 90.5 | 85.5 |
| Flame Retardant | | - | 9 | 14 |
| Anti-dripping agent | | - | 0.5 | 0.5 |
| <u>Properties</u> | | | | |
| Flame retardancy: | | | | |
| UL 94 class (1.6 mm) | | NR | V-0 | V-0 |
| MFI (240 ⁰ C; 5kg), g/10min | | 3 | 21 | 20 |
| IZOD notched impact, J/m | | 747 | 651 | 582 |
| HDT (1.81MPa), ⁰ C | | 117 | 83 | 64 |

** Triphenyl phosphate – commercial solid phosphate ester

□ **FR efficiency**

The unique combination of high phosphorus content (10.7%) and high thermal stability of *Fyrolflex*[®] *RDP* ensures good flame retardant efficiency and very good thermal properties PC/ABS alloy. In order to achieve UL-94 V-0 rating with low content of *Fyrolflex*[®] *RDP*, it is recommended to add small amount (0.2-0.5%) of polytetrafluoroethylene (PTFE) to suppress possible dripping. PTFE is preferably added in the compound as a masterbatch concentrate to ensure its homogeneous dispersion.

□ **Health – Safety - Environmental aspects**

Fyrolflex[®] *RDP* is being designed and developed to be safe and environmentally friendly in use and at the end of life, including recycling or waste incineration. Extensive toxicological and environmental testing was performed on *Fyrolflex*[®] *RDP* and it is believed that it will pose no risk to health and the environment. *Fyrolflex*[®] *RDP* is the only aromatic bis-phosphate available to the market which complies with EU Ecoflower labels for TV sets.

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As a part of an ongoing Product Stewardship Program and Customer oriented policy, ICL-IP is committed to implement further toxicological and environmental tests if needed.

□ Applications

Recommended applications of *Fyrolflex*[®] RDP in PC/ABS alloys are: business machine housings, housings of flat screen TV sets and PC monitor, appliances, scientific and analytical instrument parts, (See Figures 2 and 3).



Figure 2: Housing of flat screen TV



Figure 3: Housing of copy machine

In these applications, because of its relatively low viscosity, *Fyrolflex*[®] RDP will exhibit its inherent advantages over other products, with its ease to be compounded using low temperature of storage tanks and pumping lines. This allows energy saving and safer handling. Other advantages offered by *Fyrolflex*[®] RDP are good light stability, impact properties and thermal stabilities.

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