**Application Data Sheet for PC/ABS alloys**

**Fyrolflex® Sol-DP™**, a proprietary bisphosphate ester flame retardant (FR), is a free flowing powder offered by ICL-IP for compounding applications in styrenic copolymers, polycarbonate and their alloys. Compared with other commercial solid phosphate esters FRs, it exhibits higher phosphorus content and melting range. (see properties in Table 1 and appearance in Figure 1).

<table>
<thead>
<tr>
<th>Physical appearance</th>
<th>Off-white free flowing powder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphorus content, w %</td>
<td>10.7</td>
</tr>
<tr>
<td>Melting range, °C</td>
<td>101-108</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>1.3</td>
</tr>
<tr>
<td>Acidity, mg KOH/g</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Assay, wt %</td>
<td>&gt;98</td>
</tr>
<tr>
<td>Solubility (water)</td>
<td>insoluble</td>
</tr>
</tbody>
</table>

**Fyrolflex® Sol-DP™** is suitable for providing UL 94 V-1/V-0 ratings to several engineering plastics such as modified PPO, PC and its alloys with ABS. It can also be applied for obtaining V-2 rating ABS.

Additional inherent advantages offered by **Fyrolflex® Sol-DP™** over other phosphate ester FR additives currently used for same applications, are its contribution to low color, good clarity, excellent hydrolytic and UV stabilities.

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Being a free flowing powder, *Fyrolflex® Sol-DP™* can be used in typical solidsmetering equipment and avoids the extra cost and difficulty of handling very viscous liquids. This advantage also leads to flexibility to the compounder, as the premixed blend can be moved from one extrusion line to the other without changing equipment.

Figure 1: *Fyrolflex® Sol-DP™* is a white free flowing powder.

- **Thermal stability**

Thermo-gravimetric analysis of *Fyrolflex® Sol-DP™* (Table 2) reflects its good thermal stability permitting high processing temperatures typical for engineering plastics.

<table>
<thead>
<tr>
<th>Weight loss, %</th>
<th>Temperature, °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>300</td>
</tr>
<tr>
<td>5</td>
<td>335</td>
</tr>
<tr>
<td>10</td>
<td>350</td>
</tr>
</tbody>
</table>

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The following processing conditions were used on lab-scale equipment and given only for guidance purposes.

**Compounding**

PC and ABS should be well dried before compounding. *Fyrolflex® Sol-DP™* should be dried preferably in a vacuum oven at a maximum temperature of 70°C to avoid any risk of agglomeration.

As a powdered solid, *Fyrolflex® Sol-DP™* can be used in typical solids metering equipment. There is no need for “hard-piped” liquid feed and handling systems that are dedicated to a specific unit.

*Fyrolflex® Sol-DP™* 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® Sol-DP™* are as follows:

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

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

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

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Fyrolflex® Sol-DP™’s high purity is beneficial as it eliminates most of the mold deposits often observed with other phosphate type FR compounds.

**Properties**

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

- **FR efficiency**

The unique combination in Fyrolflex® Sol-DP™ of 10.5% phosphorus and its high heat stability provides good flame retardant efficiency and thermal stability. Figure 1 shows comparative loadings needed for solid phosphorus based FRs to get UL 94 V-0 in PC-ABS alloys (80/20). The lower use levels with Fyrolflex® Sol-DP™ typically means more of the original PC/ABS alloys properties are retained.

* Resorcinol bis(di-2,6dixylyl phosphate) – commercial solid phosphate ester

** Triphenyl phosphate – commercial solid phosphate ester

In order to get class V-0 with this low content of Fyrolflex® Sol-DP™, it is recommended to add some powdered (0.3-0.5%) polytetrafluoroethylene (PTFE) to eliminate the risk of dripping. PTFE is preferably added in the compound via a masterbatch concentrate to ensure a homogeneous blend.

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Combination of impact and heat dimensional stability properties

*Fyrolflex® Sol-DP™* is also the flame retardant of choice when an optimal combination of good impact and heat dimensional properties is needed (Figure 2).

**Fig. 2: IZOD impact & HDT in PC/ABS (80/20) (UL 94 V-0; 1.6mm)**

<table>
<thead>
<tr>
<th>Material</th>
<th>IZOD notched, J/m</th>
<th>HDT (1820kPa), °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sol-DP</td>
<td>700</td>
<td>80</td>
</tr>
<tr>
<td>RXP</td>
<td>600</td>
<td>90</td>
</tr>
<tr>
<td>RDP</td>
<td>500</td>
<td>100</td>
</tr>
<tr>
<td>BDP</td>
<td>400</td>
<td>110</td>
</tr>
<tr>
<td>TPP</td>
<td>300</td>
<td>120</td>
</tr>
</tbody>
</table>

Health – Safety - Environmental aspects

*Fyrolflex® Sol-DP™* has been designed and developed to be safe and environmentally friendly in the usage and environmentally friendly in end of life vehicles, including recycling or waste incineration.

*Fyrolflex® Sol-DP™* is undergoing extensive toxicological and environmental testing, and is expected to pose no risk to health and the environment.

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

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

<table>
<thead>
<tr>
<th>FR Type</th>
<th>Ref. no FR</th>
<th>FR Type</th>
<th>Ref. no FR</th>
<th>FR Type</th>
<th>Ref. no FR</th>
<th>FR Type</th>
<th>Ref. no FR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composition, weight %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PC/ABS (80/20)</td>
<td>100</td>
<td>91.5</td>
<td>87.2</td>
<td>91.5</td>
<td>85.5</td>
<td></td>
<td></td>
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<tr>
<td>Flame Retardant</td>
<td>-</td>
<td>9</td>
<td>12.3</td>
<td>9</td>
<td>14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anti-dripping agent</td>
<td>-</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Properties</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flame retardancy:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UL 94 class (1.6 mm)</td>
<td>NR</td>
<td>V-0</td>
<td>V-0</td>
<td>V-0</td>
<td>V-0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MFI (240°C, 5kg), g/10min</td>
<td>3</td>
<td>7</td>
<td>14</td>
<td>21</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IZOD notched impact, J/m</td>
<td>747</td>
<td>715</td>
<td>726</td>
<td>651</td>
<td>582</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HDT (1.81MPa), °C</td>
<td>117</td>
<td>90</td>
<td>88</td>
<td>83</td>
<td>64</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Resorcin bis(di-2,6dixylyl phosphate) – commercial solid phosphate ester ** Triphenyl phosphate – commercial solid phosphate ester

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Applications

Recommended applications of *Fyrolflex® Sol-DP™* in PC/ABS alloys are: copy machine parts, housings of flat screen TV sets and PC monitor, laptop, remote control, mobile phone and office equipments (scanner, fax, copy and printing machines) (See Figures 2 and 3).

**Figure 1: Housing of flat screen TV**  
**Figure 2: Housing of copy machine**

In these applications, *Fyrolflex® Sol-DP™*, being a free flowing powder, will exhibit its inherent advantages over other products, with its ease to be compounded with no need for liquid handling, good light stability and good impact and thermal stabilities. It will often be preferred over other flame retardants if higher heat distortion temperature is needed.

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