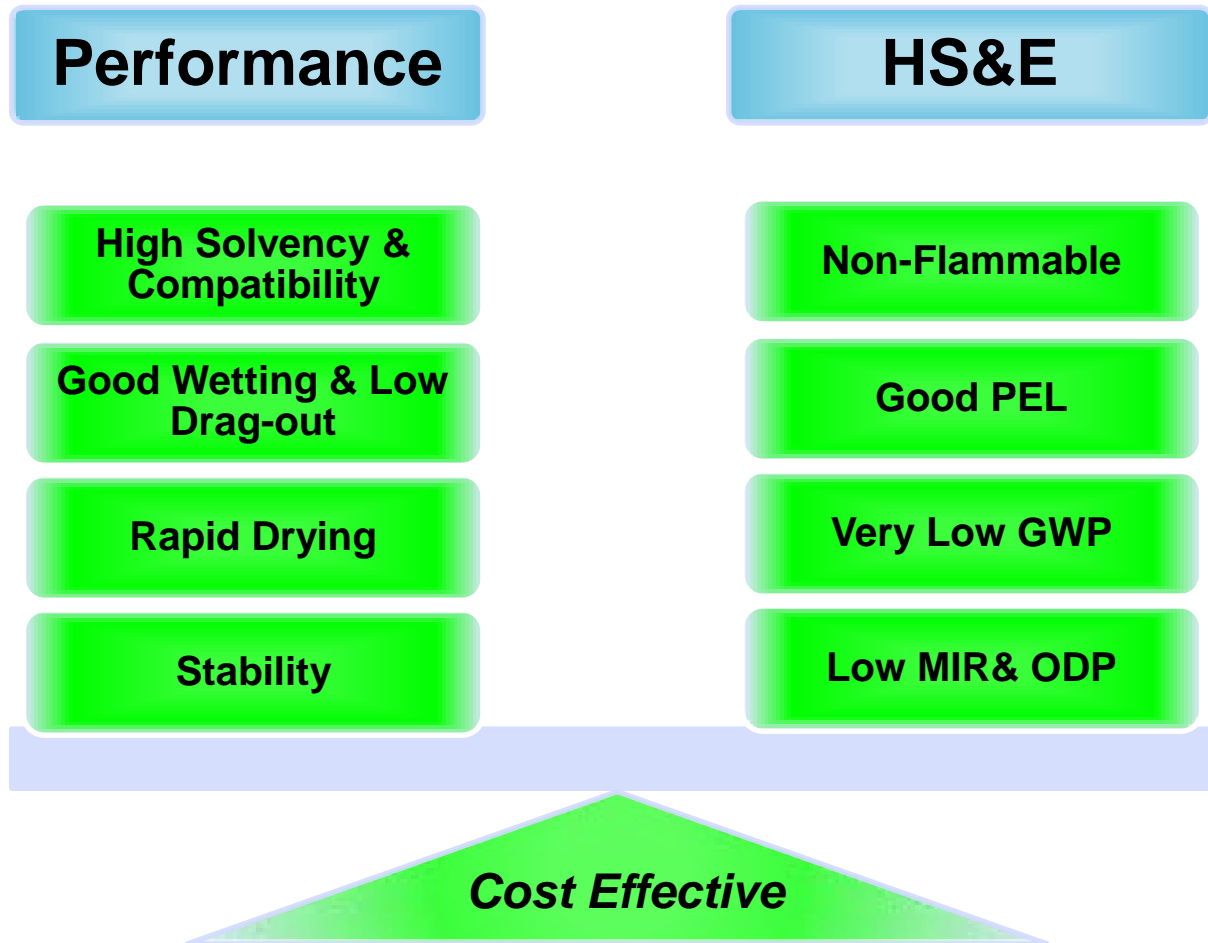


Solstice™ Performance Fluid

Honeywell

The utility of Solstice PF is the result of a complex agglomeration of properties for success in use.



Solstice™ PF – Comparison

Honeywell

Solstice PF vs. other Solvents: Comparing some properties and influence on use cost

| <i>Properties</i> | Solstice PF | Vertrel MCA | Vertrel XE | Novec 72DE | Novec 72DA | 225 ca/cb | n-PB | PERC | TCE | Aqueous |
|---|-------------|-------------|------------|------------|------------|-----------|-------|-------------|-------------|----------------------------|
| Boiling Point (°C) | 19 | 39 | 52 | 43 | 44 | 54 | 71 | 121 | 87 | 100 |
| Heat of Vaporization at boiling point, BTU/lb | 83.4 | 77.9 | 62.25 | 93.5 | 107.9 | 62.2 | 105.8 | 90.3 | 101.5 | 972 |
| Surface Tension (dynes/cm) @25° C | 12.7 | 15.2 | 14.1 | 19 | 18 | 16.2 | 25.9 | 32.3 @20° C | 29.5 @20° C | 72.8 Reduced w/ Surfactant |
| Additives Required | No | Yes | No | Yes | Yes | No | Yes | No | No | Yes |
| Cost impact | | | | | | | | | | |
| Energy Cost for Drying | Low | | | | | | | | | |
| Cleaning Cycle Time | Short | | | | | | | | | |
| Drag-out Loss | Low | | | | | | | | | |
| NVR Potential | Low | | | | | | | | | |

Balanced Set of Properties Leads to Cost Effective Solution

Solstice™ PF – Comparison

Honeywell

Solstice PF vs. other Solvents: Comparing some properties as Listed on Representative MSDS and/or Published or Honeywell Information (Solstice PF)

| Environment | Solstice PF | Vertrel MCA | Vertrel XE | Novec 72DE | Novec 72DA | 225 ca/cb | n-PB | PERC | TCE | Aqueous |
|--------------------|-------------|----------------------|----------------|--------------------------------|--------------------------------|-----------------|-----------------------|-------------------------------|------------|------------------------|
| ODP* | ~0* | ~0* | ~0* | ~0* | ~0* | 0.03 | 0.002-0.03 | 0.006 | <0.005 | N/A |
| GWP100 | <5 | 650 | 1248 | 43 | 43 | 180/620 | N/A | 800 | 140 | N/A |
| VOC or HAP | No (est.) | Yes 1,2 Trans-DCE | Yes Ethanol | Yes 1,2 Trans-DCE | Yes 1,2 Trans-DCE | No | Yes | Yes | Yes | Some Components |
| Safety | | | | | | | | | | |
| Vapor Flame Limits | No | No | No | 6.7-13.7 | 5.9-14.5 | No | 7.6-17.7 | No | 8-11 | No |
| Flammable/Flash | No | No | No | No | No | No | No | No | No | No |
| OEL** (ppm) | 800 | 214 | 235 | 750 to 200 component dependant | 750 to 200 component dependant | 25 (ca isomer) | 25-100 | 20-25 | 50-100 | Depends Upon Additives |
| Odor | Slight | Ether-Like | Ether-Like | Slight | Slight | Slight Ethereal | “Charac- teristic” | Ether or Chlorof orm | Ether-Like | Mild Detergent |

Balanced Set of Properties Leads to Cost Effective Solution

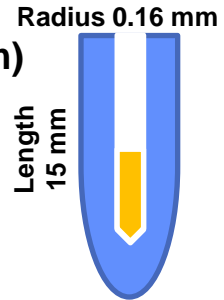
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Solstice™ PF– Performance; Capillary Cleaning










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Capillary Cleaning

1. Prepare a glass capillary that is sealed at one end (Radius = 0.16mm, Length = 15mm)
2. Pack oil inside capillary with a wire.
3. Sonicate capillary while immersed in solvent.
4. Visually evaluate if any residual oil remains.



Capillary Cleaning Results – Used Cutting Oil

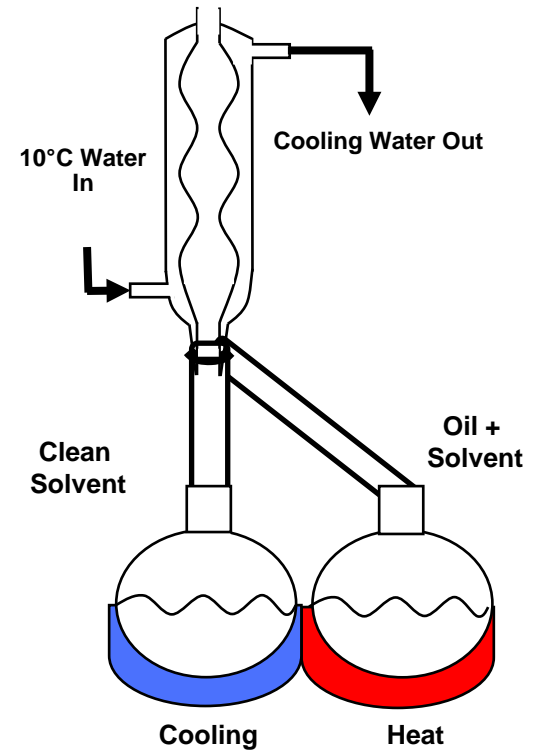
| Cleaning Time | Solstice PF | Novec 71DE | Vertrel SMT | AK-225 | PERC |
|---------------|---|--|--|--|--|
| 10 min |  |  |  |  |  |
| 1 hr + 10 min | Clean after 10 minutes |  |  |  |  |

Solstice PF Best in Class Recycling Profile

- **Honeywell's Alcohol Blends are Azeotropes**
- **No Stabilizers Needed**
- **Easy Recovery, such that**
 - **At 100°C, Ambient Pressure, ~ 95% recovered**
 - **At 100°C, 1 psi Pressure, ~ 99.5+% Recovered**

Some Competing Solvents Recycling Profile

- **Blends May Not Form Azeotropes**
then, Re-blending After Distillation is Necessary
- **Stabilizers May be Needed**
then, Adding Stabilizers After Distillation is Necessary
- **More difficult Recovery, such that**
 - **At 100°C, Ambient Pressure, ~ 0-85% recovered**
 - **At 100°C, 1 psi Pressure, ~ 94-99% Recovered**



Case Study: Aerospace facility, Competing Technology required replacement every 5 weeks because of instability, annual cost For solvent was \$52K; with Stable solvent annual cost declined to \$6k, Reflecting a savings of \$46k/yr.

Lower Cost Solvent Recovery

Solstice™ PF – Compatibility, Solubility, & Stability



**Solutes/Soils Tested
(2 Min. Immersion, Room Temp., No Agitation)
Results; Typically 90%+ Removal**

| |
|----------------------------|
| Mineral Oil |
| Solder Flux |
| Refrigerant oil |
| Silicone Lubricant |
| Krytox® 143cc Lubricant |
| Krytox® 143ax Lubricant |
| Polyalkaline Glycol |
| Fomblin® Z-Dol Lubricant |
| Vacuum pump oil |
| Cutting oil |
| Silicone oil |
| Mil-PRF-83282 |
| Mil-PRF-C-81309 |
| VV-D-1078 |
| Nye oil 438 (70%+ removal) |

**Solubility Test Flux
Solstice PF + Alcohol
(After Reflow, 1 Min. Immersion, No Agitation)
Results; 90%+ Removal**

| |
|------------|
| Rosin Flux |
|------------|

**Compatibility Tests Metals
(Immersed in Solstice PF & Refluxed with Water for 1 Week) Results; No Halides, Rust, or Pitting**

| |
|----------------------------|
| Stainless Steel 304 |
| Cold rolled steel |
| Galvanized steel |
| Aluminum |
| Copper |
| Magnesium / Aluminum Alloy |
| Titanium |

**Compatibility Tests
Plastics & Elastomers
Results; No Detrimental Effect**

| |
|------------------------|
| ABS |
| PTFE |
| PVDF |
| ACETAL |
| PET |
| HDPE |
| NYLON 66 |
| PVC |
| Poly-Carbonate |
| Polypropylene |
| VITON® B Elastomer |
| Polyurethane 390 |
| TEXIN® 285 Elastomer |
| KALREZ® 6375 Elastomer |
| NEOPRENE |

✓ **Stable** No Stabilizers Required, No Residue Removal from Additives Required

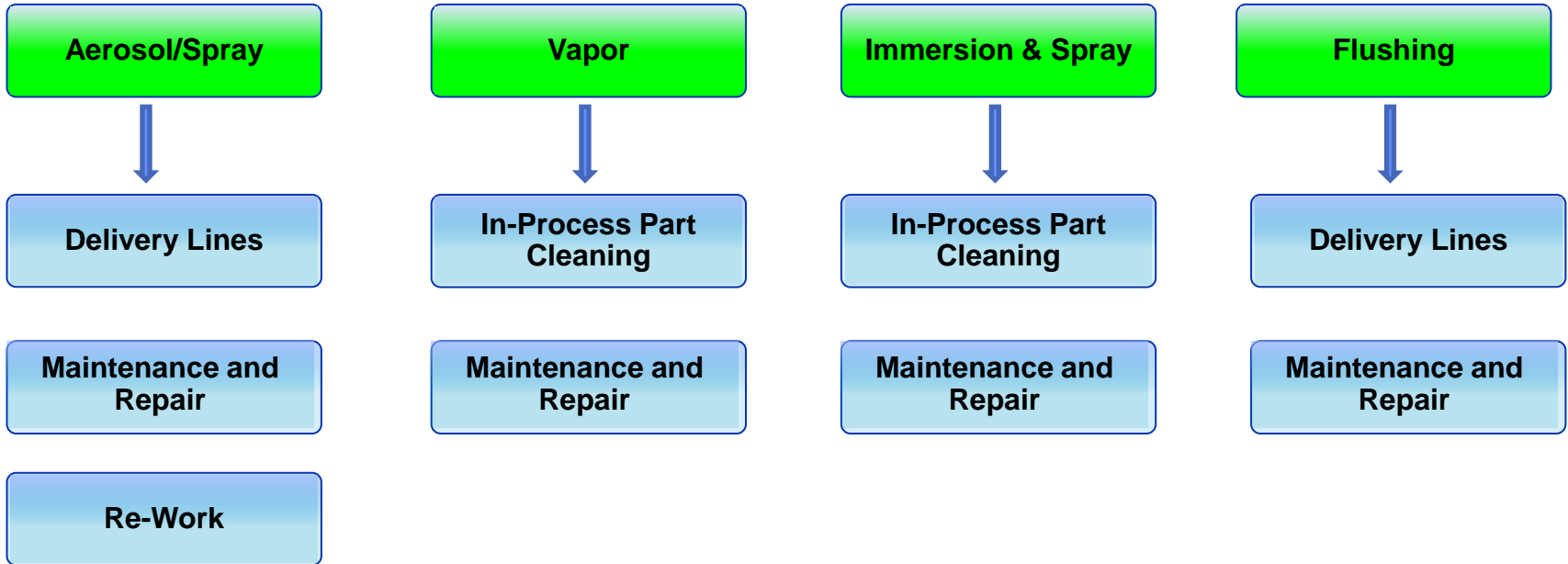
✓ **Compatible** All Metals Tested & Broad Range of Cured Plastics & Elastomers

Great Performance and Compatibility

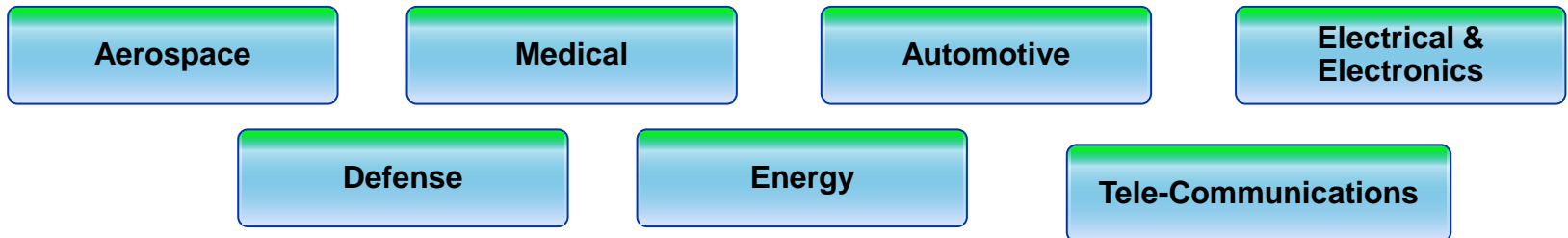
Solstice™ PF - *Diverse Cleaning Solutions*

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Delivery Methods & Applications



Industries



Suitable in Diverse Applications & Delivery Methods

Performance

- ✓ **Excellent Solvency** for a Wide Variety of Solutes (*Oils and greases, solder fluxes, etc.*)
- ✓ Improved wetting characteristics

Cost Effective

- ✓ **Reduced Energy** Requirements for Processing and Drying
- ✓ Compatible with **Activated Carbon Recovery**
- ✓ **No Post Process NVR** (non-volatile residue) **Removal**
- ✓ **Minimal Disruption** to Productivity, Process Flow and Through-put

Sustainable

- ✓ **Meets or Exceeds Regulatory and Safety Requirements**
 - GWP < 5
 - Very Short **Atmospheric Life Time: 26 days**
 - Doesn't Contribute to SMOG due to **Very Low MIR** (POCP)
- ✓ **Feedstock Widely Available**

Safe

- ✓ **Non-Flammable**
- ✓ **OEL 800ppm**

Versatile

- ✓ **Benefits can also be used in a Variety of Cleaning Applications and Delivery Methods**
EE, Metal, Plastics in Diverse Industries