LANXESS Heat Transfer Fluids for Concentrated Solar Power Plants (CSP)

Dr. Wolfgang Podestà & Mercedes Bayer

Leverkusen, 2017
LANXESS
A globally operating specialty chemicals company

Specialty chemicals company
- Spin-off from Bayer in 2004
- Specialty chemicals portfolio: chemical intermediates, specialty chemicals and plastics

Global success story
- 54 sites worldwide
- Approximately 16,700 employees in 25 countries
- Global sales of € 7.7 billion in 2016

Strategy of profitability and resilience
- Enhancing its leading position in mid-sized markets
LANXESS Distribution GmbH
Your Contact

Technical:
Dr. Wolfgang Podestà
Business Manager Baynox & Diphyl®
Phone: +49 (0)221 8885 4524
Mobile: +49(0)175 30 19 124
wolfgang.podesta@lanxess.com

Commercial:
Mercedes Bayer
Product Manager
Phone: +49 (0)221 8885 5483
Mobile: +49 (0) 151 74 61 3104
mercedes.bayer@lanxess.com

LANXESS Distribution GmbH
Kaiser-Wilhelm-Allee 40
Building K10
51369 Leverkusen, Germany
# LANXESS Heat Transfer Fluids

## Experience & Knowledge

**Experience & Know How**

- BAYER patented **Diphyl®** (DP / DPO eutectic in 1929)
- German technology
- Development of standard test methods for HTFs
- LANXESS handles HTFs in >200 production plants worldwide
- More than 10 years experience with CSP plants (initial/top-up)

**Cooperations**

- Cooperation in CSP with leading engineering companies and research centers (DLR)*
- LANXESS has partnership with leading contractors & plant construction companies
- Service partner CURRENTA with high-tech analytical laboratories and test facilities for HTFs

---

*DLR (Deutsches Zentrum für Luft- und Raumfahrt/ National aeronautics & space research centre of Germany)*
## LANXESS Heat Transfer Fluids

### DPO/DP (Diphyl®) – Preferred for Parabolic Trough CSP

<table>
<thead>
<tr>
<th>HTF components</th>
<th>Chemical structure / basic products</th>
<th>Application Range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Silicones</strong></td>
<td><img src="image" alt="Modified polydimethylsiloxane" /></td>
<td>-40 to +430°C Not yet approved, no long-term experience</td>
</tr>
<tr>
<td><strong>Aromatics</strong></td>
<td><img src="image" alt="Diphenyl oxide (DPO) and Diphenyl (DP)" /></td>
<td>+12 to +400°C approved standard for PT</td>
</tr>
<tr>
<td><strong>Salt melts</strong></td>
<td>KNO₃ – NaNO₃ Potassium/sodium nitrate</td>
<td>+230 to +550°C approved standard for solar towers, not approved for PT</td>
</tr>
<tr>
<td>Company</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>LANXESS</td>
<td>Manufacturer of high quality HTFs for many applications</td>
<td></td>
</tr>
<tr>
<td>DIN (EN)</td>
<td>Development and release of test methods</td>
<td></td>
</tr>
<tr>
<td>DLR</td>
<td>Institute for solar research</td>
<td></td>
</tr>
<tr>
<td>FLAGSOL</td>
<td>Developer and constructor of solar power plants since 40 years</td>
<td></td>
</tr>
<tr>
<td>FRAUENHOFER</td>
<td>Application oriented research</td>
<td></td>
</tr>
<tr>
<td>TÜV RHEINLAND</td>
<td>Testing, assessment &amp; certification</td>
<td></td>
</tr>
<tr>
<td>SIEMENS</td>
<td>Plant constructor</td>
<td></td>
</tr>
<tr>
<td>KRAFTANLAGEN GRUPPE</td>
<td>Energy &amp; power plant technology</td>
<td></td>
</tr>
<tr>
<td>SCHOTT SOLAR (now: RIOGLASS)</td>
<td>Solar thermal receiver technology</td>
<td></td>
</tr>
<tr>
<td>HEAT11</td>
<td>Heat transfer plant design and construction</td>
<td></td>
</tr>
</tbody>
</table>
LANXESS Heat Transfer Fluids
Diphyl® Thermal Stability Test

- When Heat Transfer Fluids (HTF) degrade, the amount of degradation increases dependent on the increase of temperature, length of exposure or both.
- Degradation products include high and low boiling components, gaseous decomposition products, and products that cannot be evaporated.
- Type and content of degradation products will change the performance characteristics of a HTF.
- Tests according to DIN 51528 and ASTM D6743-11 performed by independent laboratories:
  - DLR (Deutsches Zentrum für Luft- und Raumfahrt/ National aeronautics & space research centre of Germany)
  - CURRENTA GmbH & Co. OHG

Test results show that Diphyl®, Therminol VP-1 and Dowtherm A, containing the eutectic mixture of diphenyl and diphenyl oxide, have essentially the same physical properties and relative thermal stability.

Diphyl® can thus be used for original filling and is fully suitable for the refill of equipment that carries originally Dowtherm A or Therminol VP-1.
LANXESS Heat Transfer Fluids
Technical Analysis by DLR*

Accelerated ageing of HTF fluids for CSP plants

Fusing of degassed samples in glass ampoules
Long term storage at 400 – 450°C for up to 1000 hrs.

* DLR (Deutsches Zentrum für Luft- und Raumfahrt/ National aeronautics & space research centre of Germany)
LANXESS Heat Transfer Fluids
Technical analysis – decomposition products of Diphyl® (GC)

Diphyl® decomposes into low (50-260°C ⬆️) & high boilers (>260°C ⬇️)
LANXESS Heat Transfer Fluids
Technical analysis – decomposition of Diphyl®

Degradation according to DIN 51528

Diphyl® in glass ampoule
Static test in hot cabinet
Test period 480 hrs.

Decomposition in autoclave test
LANXESS Heat Transfer Fluids
Safety Analysis for DP/DPO use in CSP plants

- Exposure control / personal protection **Diphyl®**
- Safe handling and storage of **Diphyl®**
- Risk assessment safety precautions
- Environmental precautions
- Procedures in case of spillage
- Accidental release measures
- First aid measures
- Firefighting measures
- Disposal considerations
LANXESS Heat Transfer Fluids
References in CSP Business

<table>
<thead>
<tr>
<th>COMPANIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEAG</td>
</tr>
<tr>
<td>SOLEVAL</td>
</tr>
<tr>
<td>ABENGÖA</td>
</tr>
<tr>
<td>SAMCA</td>
</tr>
<tr>
<td>IBERDOLA</td>
</tr>
<tr>
<td>ELECNOR</td>
</tr>
<tr>
<td>TORESOL</td>
</tr>
<tr>
<td>IBEROLICA</td>
</tr>
<tr>
<td>MARQUESADO SOLAR</td>
</tr>
<tr>
<td>NEXTERA</td>
</tr>
</tbody>
</table>
LANXESS Heat Transfer Fluids
Service for CSP

- Production sites in Germany, India and China
- Stock points
- Local contacts (agencies)
- Delivery in ISO tankers
- Qualified logistics partners
- Intermediate buffer stocks
- Delivery of heated containers
- Road transport to CSP
- Pre & after sales support
- Sustainable solutions
- Regeneration of used HTF

- Production/ Storage facilities
- Marketing/ Sales Offices
LANXESS Heat Transfer Fluids
Logistics / Supply Chain

**Equipment**
- LANXESS cooperates with global logistics partners with own ISO tanker fleet
- ISO tankers must have highest technical and safety standards

**Logistics**
- LANXESS uses stockpoints in Germany, India and China
- Development of logistics concept
- Offering intermodal network (road, rail, sea)
- Evaluation of storage terminal close to CSP plant
- Coordination monitoring of the supply chain

**Task force**
- Heating operation
- Technically experienced contractor accompanies unloading process
LANXESS commands of a broad portfolio of references for initial filling and top up business worldwide.

For detailed information please contact:

**Technical:**

Dr. Wolfgang Podestà  
Business Manager Baynox & Diphyl  
Phone: +49 (0)221 8885 4524  
Mobile: +49(0)175 30 19 124  
wolfgang.podesta@lanxess.com

**Commercial:**

Mercedes Bayer  
Product Manager  
Phone: + 49 (0) 221 8885 5483  
Mobile: +49 (0) 151 74 61 3104  
mercedes.bayer@lanxess.com

LANXESS Distribution GmbH  
Kaiser-Wilhelm-Allee 40  
Building K10  
51369 Leverkusen, Germany
LANXESS Heat Transfer Fluids
Certificate of Comparability / Lanxess Quality Certificate

To whom it may concern

LANXESS DIPYLYL - Statement of Compatibility

DIPYLYL of LANXESS contains two chemical substances, that mixed under all aspects of quality assurance to achieve a so called substitute mixture of dipropylene and dipinane. From a physical standpoint essential properties of DIPYLYL polymer, dynamic viscosity, solidification point, boiling point, max. bulk temperature can be expected to be similar to other products available on the market (e.g. Dowtherm A and Thermoﬂuid (VF)). To the best of our knowledge, DIPYLYL is miscible, in other words, DIPYLYL can act as a filling agent in equipment, that carries originally either Dowtherm A or Thermoﬂuid (VF). In that respect and also to the best of our knowledge, we do not expect an impact to any of these properties within the field of heat transfer fluid application.

You receive the information for your consideration and assessment in regard of your specific requirement; it shall neither be deemed to constitute a warranty of fitness for purpose, nor is it a "Guarantee" in the sense of Art. 444 of the German Civil Code (DGB).

*Comparison of essential properties
LANXESS Heat Transfer Fluids
Concentrated Solar Power Industry

- LANXESS is a well known partner in the CSP community
- LANXESS has been operating for more than 10 years in the field of CSP supported by German engineer and research companies (Flagsol, DLR)
- LANXESS supplied Diphyl® for start-up CSP plant in Los Arenales / Spain and refill for several plants
- LANXESS is regularly involved in new CSP projects worldwide (new plants and top up of existing plants)
- LANXESS internally / externally analysed CSP market and technology development
- LANXESS is looking for further CSP projects worldwide
- LANXESS is on an equal footing with other suppliers and therefore

THE RIGHT CHOICE
QUALITY HEATS.
Disclaimer

Health and Safety Information: Appropriate literature has been assembled which provides information concerning the health and safety precautions that must be observed when handling the LANXESS products mentioned in this publication. For materials mentioned which are not LANXESS products, appropriate industrial hygiene and other safety precautions recommended by their manufacturers should be followed. Before working with any of these products, you must read and become familiar with the available information on their hazards, proper use and handling. This cannot be overemphasized. Information is available in several forms, e.g., material safety data sheets, product information and product labels. Consult your LANXESS representative in Germany or contact the Regulatory Affairs and Product Safety Department of LANXESS Deutschland GmbH or - for business in the USA - the LANXESS Product Safety and Regulatory Affairs Department in Pittsburgh, PA, USA.

Regulatory Compliance Information: Some of the end uses of the products described in this publication must comply with applicable regulations, such as the FDA, BfR, NSF, USDA, and CPSC. If you have any questions on the regulatory status of these products, contact – for business in the USA- your LANXESS Corporation representative, the LANXESS Regulatory Affairs Manager in Pittsburgh, PA, USA or for business outside US the Regulatory Affairs and Product Safety Department of LANXESS Deutschland GmbH in Germany.

The manner in which you use and the purpose to which you put and utilize our products, technical assistance and information (whether verbal, written or by way of production evaluations), including any suggested formulations and recommendations are beyond our control. Therefore, it is imperative that you test our products, technical assistance and information to determine to your own satisfaction whether they are suitable for your intended uses and applications. This application-specific analysis must at least include testing to determine suitability from a technical as well as health, safety, and environmental standpoint. Such testing has not necessarily been done by us. Unless we otherwise agree in writing, all products are sold strictly pursuant to the terms of our standard conditions of sale. All information and technical assistance is given without warranty or guarantee and is subject to change without notice. It is expressly understood and agreed that you assume and hereby expressly release us from all liability, in tort, contract or otherwise, incurred in connection with the use of our products, technical assistance, and information.

Any statement or recommendation not contained herein is unauthorized and shall not bind us. Nothing herein shall be construed as a recommendation to use any product in conflict with patents covering any material or its use. No license is implied or in fact granted under the claims of any patent.