

Solvent deasphalting by ROSE® process

PEP Review 2026-05

Roberto Tapia, Associate Director, Process Economics Program

To learn more or to request a demo, visit www.spglobal.com/commodityinsights.

Table of contents

1 Introduction	8
2 Summary	9
Industrial aspects	10
Technical aspects	11
Economic aspects	13
Environmental footprint summary	14
3 Industry status	15
SDA overview	15
Commercial aspects	16
Regulations	17
Markets	17
SDA outlook	19
4 Technology review	20
SDA feedstock	20
Fundamentals of solvent asphalt extraction	22
Asphalt extraction principle	22
Asphalt extraction column	24
Fundamentals of supercritical solvent recovery	25
Supercritical fluid properties	25
Solubility	28
Supercritical DAO separator	29
SDA integration in refineries	30
Products of solvent deasphalting	33
Solvent deasphalted oil (DAO)	33
Asphaltenes (SDA pitch)	34
Resin	34
Future outlook of SDA	35
The ROSE® process	35
Introduction	35
Process description	35
Feed system and solvent mixing	36
Asphaltene separator	36
ROSE® heat exchanger and auxiliary heater	36
DAO separator	37
DAO stripper	37
Asphaltene stripper	37
Solvent surge condenser and solvent surge tank	37

Performance	38
Design and operation parameters	38
UOP/FWUSA	39
Introduction	39
Process description	40
Performance	41
Design and operation parameters	41
SolvahI™ process	42
Introduction	42
Process description	42
Performance	43
Design and operation parameters	44
5 Economics of solvent deasphalting	45
Introduction	45
Basis of design	45
Process description	46
Process discussion	49
Plant capacity	49
Feedstock	49
Asphalt extraction column and DAO separator	49
Solvent selection	50
Recycle solvent surge vessel capacity	50
Makeup solvent storage capacity	50
Materials of construction	50
Environmental	50
Cost estimates	52
Fixed capital cost	52
Production cost	53
Appendix A — Design and cost basis	56
Design conditions	57
Cost basis	57
Capital investment	57
Project construction timing	58
Available utilities	58
Production costs	59
Effect of operating level on production costs	59
Appendix B — Cited references	60
Appendix C — Process flow diagrams	63

Tables

Table 2.1 Major SDA technologies comparison	12
Table 2.2 Solvent deasphalting by the ROSE® process — Cost summary	13
Table 2.3 Effect of plant size and cost summary — Total capital investment	13
Table 2.4 Solvent deasphalting by the ROSE® process — Carbon and water footprint	14
Table 4.1 Effect of SDA solvent selection on maximum DAO yield	23
Table 4.2 Quality effect of solvent/feedstock ratio	24
Table 4.3 Critical temperature and pressure for SDA solvents	26
Table 4.5 ROSE® reported results	38
Table 4.6 Results for a Kuwait vacuum residue SDA plant	41
Table 4.7 Yield and product quality from the Solvahl™ SDA process	43
Table 5.1 Solvent deasphalting by the ROSE® process — Design bases and assumptions	45
Table 5.2 Solvent deasphalting by the ROSE® process — Major stream flows	47
Table 5.2 Solvent deasphalting by the ROSE® process — Major stream flows (continued)	47
Table 5.2 Solvent deasphalting by the ROSE® process — Major stream flows (concluded)	48
Table 5.3 Solvent deasphalting by the ROSE® process — Major equipment	48
Table 5.4 Solvent deasphalting by the ROSE® process — Utility summary	49
Table 5.5 Solvent deasphalting by the ROSE® process — Summary of major waste streams	51
Table 5.6 Solvent deasphalting by the ROSE® process — Carbon footprint	51
Table 5.7 Solvent deasphalting by the ROSE® process — Water footprint	52
Table 5.8 Solvent deasphalting by the ROSE® process — Total capital investment	53
Table 5.9 Solvent deasphalting by the ROSE® process — Variable costs	54
Table 5.10 Solvent deasphalting by the ROSE® process — Production costs	55

Figures

Figure 2.1 Reported number of installed SDA units by technology	10
Figure 2.2 Global demand by refined product (MMbpd)	11
Figure 3.1 Reported number of installed SDA units by technology	16
Figure 3.2 Global demand by refined product (MMbpd)	18
Figure 3.3 Residual fuel oil demand by region (kbpd)	18
Figure 4.1 Arabian Light asphalt and deasphalting partition	21
Figure 4.2 Solvent deasphalting block diagram	21
Figure 4.3 Distribution of sulfur, nitrogen, and metals in typical deasphalted oil	22
Figure 4.4 Effect of yield on DAO/feed ratio as a function of feedstock API gravity	23
Figure 4.5 Supercritical conditions	25
Figure 4.6 Density and viscosity at supercritical conditions	27
Figure 4.7 Solvent deasphalting process on a Mollier diagram	29
Figure 4.8 Usual integration of solvent deasphalting in refining	31
Figure 4.9 KBR schemes for upgrading heavy oils using the ROSE® SDA and processing used motor oil	32
Figure 4.10 Axens-patented SDA-H-Oil™ refinery integrations for VR upgrading targeting high gasoline yield	33
Figure 4.11 ROSE® process flow diagram	36
Figure 4.12 UOP/FWUSA solvent deasphalting process	40
Figure 4.13 Solvahl™ SDA process	43
Figure 5.1 ROSE® asphaltene separator and DAO separator internal arrangement	50

Appendix C Figures

Figure C1 Solvent deasphalting process diagram by the ROSE® process	64
---	----

Glossary

\$	US dollars
°C	Degree Celsius
AD	Atmospheric distillation
AR	Atmospheric residue
Barg	Bar gauge
BFD	Block flow diagram
BFW	Boiling feedwater
BLI	Battery limits investment
bpd	Barrels per day
Btu	British thermal units
Capex	Capital expenses
CCR	Conradson carbon residue
cP	Centipoise
CTC	Crude-to-chemicals
cf	Cubic feet
CW	Cooling water
DAO	Deasphalted oil
DRU	Diluent recovery unit
ECA	Emission control area
FCC	Fluid catalytic cracking
ft	feet
GO	Gas oil
gpm	Gallons per minute
h	Hours
HDS	Hydrodesulfurization
HFO	Heavy fuel oil
HSFO	High-sulfur fuel oil
HT	Hydrotreating unit
IMO	International Maritime Organization
JV	Joint venture
kbpd	Thousand barrels per day
kg	Kilograms
kJ	Kilojoules
kPa	Kilopascal absolute
kPg	Kilopascal gauge
lb	Pound
LEDA	Low energy deasphalting process
LGO	Light gas oil
lv%	Liquid volume percent
MMbpd	Million barrels per day
MMlb/y	Million pounds per year
MMt	Million metric tons
MMt/y	Million metric tons per year
mol%	Molar percent
OWT	Oily water treatment
Opex	Operating expenses
OSBL	Outside battery limits
PEP	Process Economics Program
PFD	Process flow diagram
ppb	Parts per billion
ppm	Parts per million
ppmw	Parts per million by weight
psi	Pounds per square inch
psia	Pounds per square inch absolute
psig	Pounds per square inch gauge

R&D	research and development
RDC	rotating disc-contactor
RFCC	Residue fluid catalytic cracking
ROI	Return on investment
S/F	Solvent-to-feed
s	Second(s)
SAGD	Steam-assisted gravity drainage
SARA	Saturates, aromatics, resins, and asphaltenes
SDA	Solvent deasphalting
scf	Standard cubic feet
scm	Standard cubic meter
STM	Steam
t	Metric ton
TBP	True boiling point
TFC	Total fixed capital
USGC	US Gulf Coast
vol%	Volume percent
VD	Vacuum distillation
VGO	Vacuum gas oil
VR	Vacuum residue
w	Weight
wt%	Weight percent
y	Year

Abstract

Stricter environmental regulations and technological advances have substantially reduced the market for residual fuels, making the ability to upgrade bottom-of-the-barrel streams a key competitive differentiator for refineries. This is particularly relevant given the industry's shift to low-sulfur marine fuels, which intensifies the need to process heavy fractions. As demand for transportation fuels declines, some refineries are evaluating non-energy products to preserve the value of processed crude, with solvent-based lubricant production emerging as a viable option for facilities equipped with solvent deasphalting (SDA) units. A major advantage of SDA is its lower capital expenditure (capex) and operational expenditure (opex) relative to other residue-upgrading routes, such as hydrogen-addition technologies, although those alternatives typically deliver higher conversion.

Three previous Process Economics Program (PEP) reports address certain aspects of SDA, but none are dedicated exclusively to SDA, and a comprehensive economic analysis of SDA has not yet been conducted. In this review, we will review the current industrial status of SDA. A brief technology overview of the major SDA processes will be presented, followed by a detailed technoeconomic assessment of KBR's Residuum Oil Supercritical Extraction (ROSE®) technology.

This is PEP's independent assessment based on information presented in open literature, such as patents or technical articles, and may not reflect in whole or in part the actual plant configuration. It is believed that these sources are sufficient to represent the process and process economics within the range of accuracy necessary for the economic evaluation of the conceptual process design of this technology.

Contacts

Roberto Tapia

Associate Director, Process Economics Program
roberto.tapia@spglobal.com

Rajiv Narang

Executive Director, Global Head, Process Economics Program
rajiv.narang@spglobal.com

CONTACTS

Europe, Middle East, Africa: +44 (0) 203 367 0681

Americas: +1 800 332 6077

Asia-Pacific: +60 4 296 1125

www.spglobal.com/energy

www.spglobal.com/en/enterprise/about/contact-us.html

© 2026 by S&P Global Inc. All rights reserved.

S&P Global, the S&P Global logo, S&P Global Energy, and Platts are trademarks of S&P Global Inc. Permission for any commercial use of these trademarks must be obtained in writing from S&P Global Inc.

You may view or otherwise use the information, prices, indices, assessments and other related information, graphs, tables and images ("Data") in or on this publication only for your personal use or, if you or your company has a license for the Data from S&P Global Energy and you are an authorized user, for your company's internal business use only. You may not publish, reproduce, extract, distribute, retransmit, resell, create any derivative work from, use in any artificial intelligence system, and/or otherwise provide access to the Data or any portion thereof to any person (either within or outside your company, including as part of or via any internal electronic system or intranet), firm or entity, including any subsidiary, parent, or other entity that is affiliated with your company, without S&P Global Energy's prior written consent or as otherwise authorized under license from S&P Global Energy. Any use or distribution of the Data beyond the express uses authorized in this paragraph above is subject to the payment of additional fees to S&P Global Energy.

S&P Global Energy, its affiliates and all of their third-party licensors disclaim any and all warranties, express or implied, including, but not limited to, any warranties of merchantability or fitness for a particular purpose or use as to the Data, or the results obtained by its use or as to the performance thereof. Data in this publication includes independent and verifiable data collected from actual market participants. Any user of the Data should not rely on any information and/or assessment contained therein in making any investment, trading, risk management or other decision. S&P Global Energy, its affiliates and their third-party licensors do not guarantee the adequacy, accuracy, timeliness and/or completeness of the Data or any component thereof or any communications (whether written, oral, electronic or in other format), and shall not be subject to any damages or liability, including but not limited to any indirect, special, incidental, punitive or consequential damages (including but not limited to, loss of profits, trading losses and loss of goodwill).

ICE index data and NYMEX futures data used herein are provided under S&P Global Energy's commercial licensing agreements with ICE and with NYMEX. You acknowledge that the ICE index data and NYMEX futures data herein are confidential and are proprietary trade secrets and data of ICE and NYMEX or its/their licensors/suppliers, and you shall use best efforts to prevent the unauthorized publication, disclosure or copying of the ICE index data and/or NYMEX futures data.

Permission is granted for those registered with the Copyright Clearance Center (CCC) to copy material above for internal reference or personal use only, provided that appropriate payment is made to the CCC, 222 Rosewood Drive, Danvers, MA 01923, phone +1-978-750-8400. Reproduction in any other form, or for any other purpose, is forbidden without the express prior permission of S&P Global Inc. For article reprints contact: The YGS Group, phone +1-717-505-9701 x105 (800-501-9571 from the U.S.).

For all other queries or requests pursuant to this notice, please contact S&P Global Inc. via email at support.energy@spglobal.com.