

Components reacting with S	Temperature intervals (°C)	Experimental concentration (when given)	Products	Interactions (experimentally determined)	Effects on S-viscosity
<p><b>Organics</b></p> <p><b>Hydrocarbons</b></p>	<p>a) 180-210°C</p> <p>b) 260 °C</p>	> 0.01 wt%	<p>- minute amounts of <b>H<sub>2</sub>S<sub>x</sub></b> (a);</p> <p>- evident formation of <b>H<sub>2</sub>S<sub>x</sub></b> (b);</p> <p>- <b>CS<sub>2</sub></b> (after few hours of boiling);</p> <p>- <b>H<sub>2</sub>S release</b> after prolonged boiling of S+ organics/hydrocarbons)</p> <p>No evident effects until T &gt;200°C</p>	dependent on the presence of H <sub>2</sub> S / H <sub>2</sub> S <sub>x</sub> dissolved in S and stabilized by S.	<p>(b) Decrease (<math>\mu</math> &lt; 4Pa·s) during a first cooling cycle (230-170 °C); this <u>behavior disappears after “several” cooling -heating cycles</u></p>
<p><b>H<sub>2</sub>S</b></p> <p><b>OPEN- CLOSED conditions</b></p>	<p><u>OPEN:</u></p> <p>a) 140 °C</p> <p>b) 125-190 °C (*1.5 hr)</p> <p>c)180-210 °C</p> <p>e) &gt;180-210 °C (long kept)</p> <p><u>CLOSED:</u></p> <p>f)&gt; 180°C</p>	<p>a) Dissolved H<sub>2</sub>S (*100 hrs)</p> <p>b) Dissolved H<sub>2</sub>S</p> <p>c) Dissolved H<sub>2</sub>S [44 minute amounts- no value given]</p> <p>d) 0.4%-1.68% [45]</p>	<p><b>H<sub>2</sub>S<sub>x</sub> formation (S+ H<sub>2</sub>S)</b></p> <p><b>d) H<sub>2</sub>S<sub>x</sub> volatilization for longer treatment &gt; T</b></p> <p>d-e) due to low H<sub>2</sub>S solubility in S -high H<sub>2</sub>S pressure needed to dissolve H<sub>2</sub>S in S (from 160-360°C[45]- cfr recent results by [28])</p>	Organics- H <sub>2</sub> S <sub>x</sub> - ammonia	<p>a) <math>\mu</math> = 65-70 Pa·s (rising T);</p> <p>b): <u>NO VISCOUS STAGE</u> (<math>\mu</math> =0.09 Pa·s ( cf. 93.2 Pa·s pure S) for a “slow” T raise)</p> <p>c) <math>\mu</math> =10-14 Pa·s after T heating/cooling cycles</p> <p>d) <math>\mu</math>=0.11 Pa·s (*at 260°C) to <math>\mu</math>=0.03 Pa·s (*at 260°C)</p> <p>e) the longer kept above T interval – the higher <math>\mu</math> on cooling</p> <p>f) Low <math>\mu</math> can be</p>

					maintained for indefinite time [44-45]
<b>H<sub>2</sub>S<sub>x</sub> (H<sub>2</sub>S<sub>2</sub> to H<sub>2</sub>S<sub>10</sub>)</b>	a) 75 °C b) 100 °C c) 125-170°C d)>180 °C	5wt%	a) <b>H<sub>2</sub>S<sub>2</sub> boils</b> with decomposition; b) some <b>H<sub>2</sub>S<sub>x</sub> rapid decomposition</b>	H <sub>2</sub> S <sub>x</sub> stability increases by S, H <sub>2</sub> S and organics; H <sub>2</sub> S liberation (H <sub>2</sub> S <sub>x</sub> dissolve in S at 120°C) c) <b>H<sub>2</sub>S bubbling with rising T</b>	c-d) μ=0 Pa·s  μ < 0.4 Pa·s (at 260 °C) after cooling (kept at 132°C *14 hrs)
<b>H<sub>2</sub>SO<sub>4</sub></b> (byproduct of SO <sub>2</sub> disproportionation; amounts depending on T> 300°C, 4SO <sub>2</sub> +4H <sub>2</sub> O= H <sub>2</sub> S+3H <sub>2</sub> SO <sub>4</sub> ; T>300°C=3SO <sub>2(aq)</sub> +2H <sub>2</sub> O=S <sup>0</sup> +2H <sub>2</sub> SO <sub>4</sub> )	A) 125 to 160°C	0.038-0.05 wt%	-----	-----	No value provided
<b>Chlorine</b>  <b>OPEN -CLOSED System</b>	>180 °C (measurements up to >400 °C)	OPEN a)1.8 % as SCl <sub>2</sub> b) 5 % as SCl <sub>2</sub>	SCl <sub>2</sub>	Elemental S	Viscosity measured at T=200°C maintaining T=190-200°C (at 0.22 mm Hg [44-45]*) A) μ= 0.3 Pa·s (at B) μ= 0.015 Pa·s
<b>Fluorine</b>	----- [44-45]	-----	-----	No data provided, only a phrase “ ...decreasing effectiveness in decreasing viscosity Chlorine, bromine and iodine. Fluorine would probably head the group [44]	-----
		OPEN			a) μ= *0.08 Pa·s

<b>Bromine</b>  <b>OPEN -CLOSED System</b>	>180 °C (measurements up to >400 °C)	a) 1% as Br <sub>2</sub> b) 8% as Br <sub>2</sub>  CLOSED c) 2% as Br <sub>2</sub>			(at 280 °C) b) $\mu$ = *0.005Pa·s (at 280 °C) c) $\mu$ = *0.005Pa·s (at 300 °C)
<b>Iodine</b>  <b>OPEN -CLOSED System</b>	> 180 °C (measurements up to >400 °C)	OPEN a) 3 %as I <sub>2</sub> b) 10% as I <sub>2</sub>  CLOSED c) 3% as I <sub>2</sub> d) 6% as I <sub>2</sub>			a)* $\mu$ = 0.08 Pa·s (at 280°C) b) * $\mu$ = 0.03 Pa·s (at 240 °C) c) * $\mu$ = 0.03 Pa·s (at 280 °C) d) * $\mu$ = 0.04 Pa·s (at 240°C)
<b>Ammonia</b>	A) 140°C (23 to 600 hrs)  B) 190 °C (40 hrs)	Gas fluxed through S ( no amounts given)	Formation of H <sub>2</sub> S <sub>x</sub> and H <sub>2</sub> S <b>(ammonia +S)</b>  Slow reaction		A) slow reaction $\mu$ =74-76 Pa·s)  B) 60 Pa·s

Table S1. Schematic effects of different components on sulfur-viscosity at different temperatures, with respect to pure sulfur (maximum  $\mu$  =93.2 Pa·s at 186-188°C-) according to experimental industrial studies in the '40s [43,44,45]. Data refers to components mixed /fluxed with(in) the pure substance. ( \*) refers to maximum values measured. Common products and interactions between components are shown.