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Oil Viscosity Modifier
Dutral OCP

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Dutral OCP

Dutral OCP is an oil soluble solid copolymer (Ethylene/Propylene Copolymer). It's one of the different type of VM. Added to the oil it reduces the tendency to change its viscosity with temperature in order to improve its Viscosity Index (see ASTM D 2270) and flow characteristics.

Improving Viscosity Index helps in maintaining constant the flow properties of the protective oil film. This means a high enough viscosity to avoid damages on engine parts when the temperature rises because of the engine heat and a low enough viscosity against the cold start and pumping.

Dutral OCP

Dutral OCP is just a V.I. improver and oil viscosity thickener. It doesn't have any other properties: Detergent/ Dispersant/Pour Point Depressant/Antiwear/Corrosion Inhibitor/Antioxidant etc.).

Dutral OCP has good compatibility with all Mineral and Synthetic Base Stocks (slightly less with esters of dibasic acids and polyol esters).

The polymer is dissolved directly in a base stock diluent to form a viscosity index improver (V.I.I.) generally at a treat rate that depends on the base stock viscosity and OCP TP: generally the final V.I.I. viscosity is around 1000 cSt at 100°C that means a treat rate from 6 to 10%.

Dutral OCP

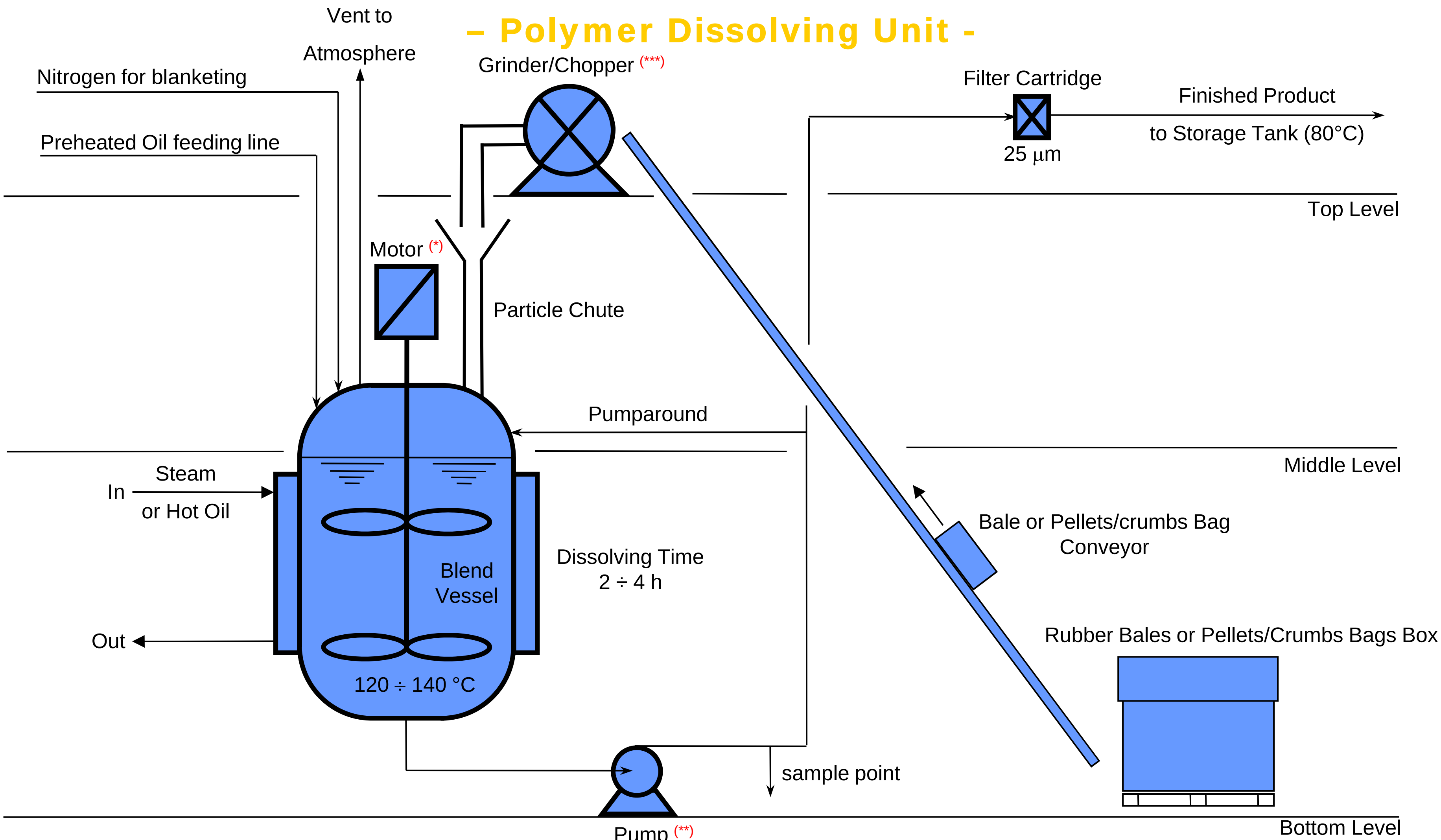
The polymer is in bale form or pellets and can be dissolved in a blending unit (see following polymer dissolving unit).

Dissolving Equipment:

- Base stock charge facilities
- Heating system (steam or hot oil flowing in internal coils, heating jacket or external heat exchanger with a pumparound circuit) to obtain and maintain dissolving temperatures of 120 ¸ 140 °C (skin temperature not exceed 200°C). Too high temperature can lead to darkening and viscosity loss. Too low temperature leads to longer dissolving cycle and presence of undissolved polymer.
- Adequate agitation to mix the polymer and base stock (top entry two pitched blade turbines providing 15 hp/1000 US gal (3785,4 litre)). High shear pumparound (at least every 15 min. turn the total content) may be used to reduce dissolving cycle time. Stagnant zone must be avoided for preventing polymer agglomeration.

Dutral OCP

– Polymer Dissolving Unit -



(*) **Power: 15 hp/1000 gal** (**) **Flow Rate: 4 x Blend Vessel Volume/h** (***) **Not needed in case of rubber in pellets/crumbs**

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Dutral OCP

Dissolving Equipment (continue):

- Polymer granulator to chop the bales or dosage system for pellets (feed weighting bulk solids pump) to charge polymer into the stirred vessel.
- An overhead line on the vessel to vent the hot fumes to a safe location or a treatment system of emissions.
- Sampling system to take periodic samples from the vessel.
- Discharge pump designed for the target viscosity of the product.
- In-line filter (25 micron bag or cartridge) before entering storage tanks.
- Accurate charging facilities for eventually adding Pour Point Depressant.
- If necessary, a system for nitrogen blanket when the oil colour stability is inadequate at the dissolving temperature.

Dutral OCP

If facilities are well designed the dissolving time is about 2 ¸ 3 hours and the entire cycle including load/discharge stages is about 4 hours. The dissolving time depends on the size of granulated solid rubber particles.

In dissolvers with internal coils, the coils must be covered before polymer charge starts to avoid polymer melting on the coils and adhering to them. Moreover in such dissolvers agitation must be strong enough to avoid dead zone between the coils and the vessel wall in which polymer can be accumulated.

The polymer charge can be started as soon as the mixer blades is sufficiently covered with oil to allow for safe starting. Never stop the mixer after polymer charge to avoid agglomeration of the floating polymer.

The dissolving stage is finished when the samples' viscosity doesn't change any more and/or there is no undissolved polymer in the samples.

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Finished V.I.I. should be stored in an agitated tank with temperature control (bulk storage temperature = 70 ÷ 80°C (max skin storage temperature = 110°C), transfer temperature for short time = 90 ÷ 110 °C (max skin storage temperature = 150°C)) and is recommended a nitrogen blanketing to minimize colour degradation. Skin temperature of heating system should not exceed 150°C.

When the polymer is added to the oil (mineral or synthetic base stocks) the lubricant is able to meet two or more SAE viscosity grades (see SAE Viscosity Grades) simultaneously obtaining in this way a product called Multi-Grade oil.

Dutral OCP

- SAE Viscosity Grades -

API Engine Oil Classifications 2002

SAE Viscosity Grade	Low Temperature (°C) Cranking Viscosity [3] (cP) Max	Low Temperature (°C) Pumping Viscosity [4] (cP) Max with no Yield Stress [4]	Low Shear Rate Kinematic Viscosity [5] (cSt) at 100°C Min	Low Shear Rate Kinematic Viscosity [5] (cSt) at 100°C Max	High Shear Rate Viscosity [6] (cP) at 150°C Min
0W	6200 at -35	60000 at -40	3,8		
5W	6600 at -30	60000 at -35	3,8		
10W	7000 at -25	60000 at -30	4,1		
15W	7000 at -20	60000 at -25	5,6		
20W	9500 at -15	60000 at -20	5,6		
25W	13000 at -10	60000 at -15	9,3		
20			5,6	< 9,3	2,6
30			9,3	< 12,5	2,9
40			12,5	< 16,3	2,9 (0W-40, 5W-40, 10W-40 grades)
40			12,5	< 16,3	3,7 (15W-40, 20W-40, 25W-40, 40 grades)
50			16,3	< 21,9	3,7
60			21,9	< 26,1	3,7

(1) 1 cP = 1 mPa*s; 1 cSt = 1 mm^2/s

(2) All values are critical specifications as defined by ASTM D3244

(3) ASTM D 5293 (shear rate 10^4 ¸ 10^5 s^{-1})

(4) ASTM D 4684 (shear rate 1 ¸ 50 s^{-1})

(5) ASTM D 445 (shear rate less than 10 s^{-1})

(6) ASTM D 4683, CEC L-36-A-90 (ASTM D 4741) or D 5481(shear rate 10^6 s^{-1})

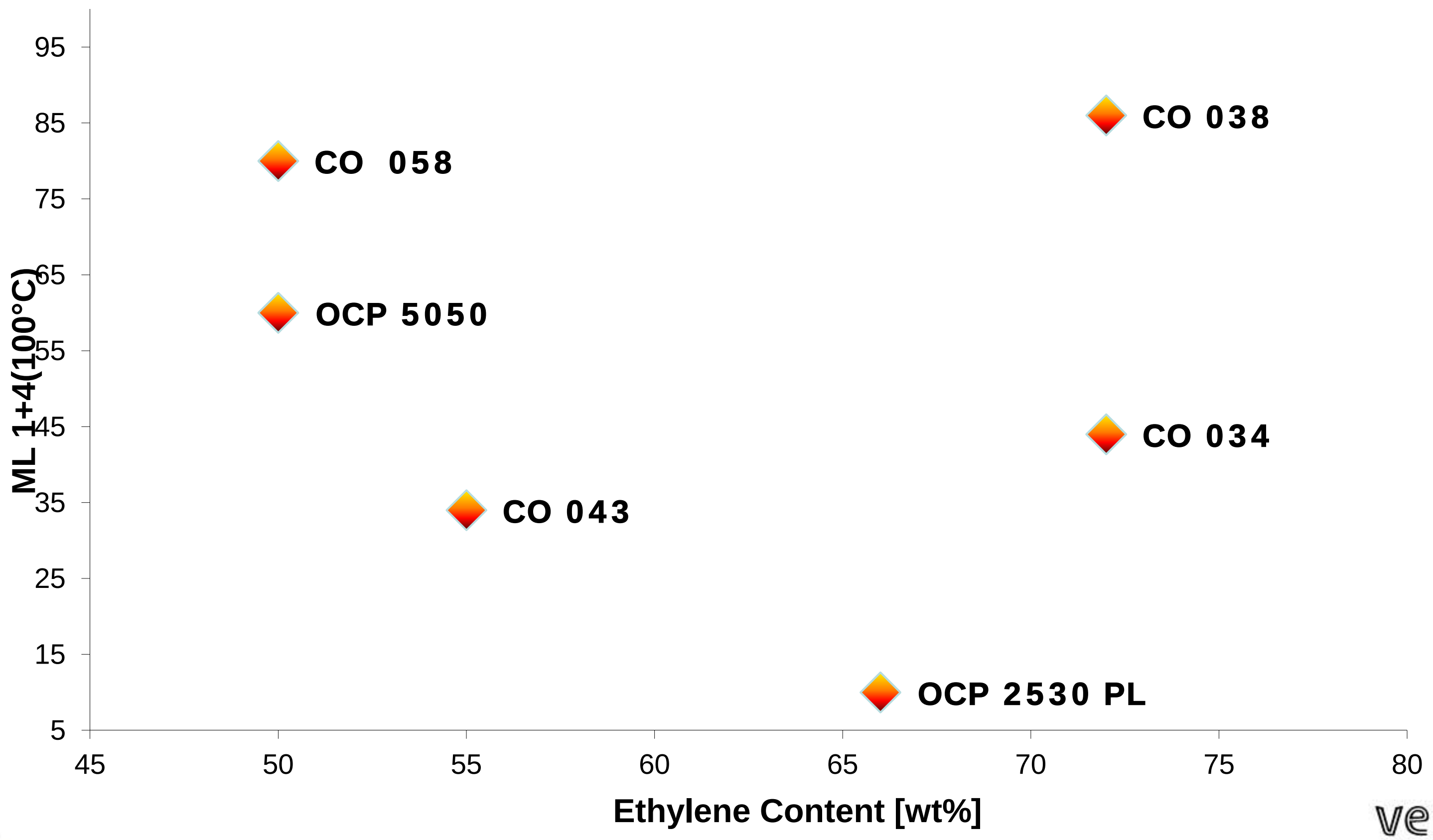
Dutral OCP

Dutral OCP are widely used for motor oil due to the excellent balance between performance and cost:

- ❑ high Thickening Power (TP): linear chain.
- ❑ good oxidative stability: single carbon to carbon bond.
- ❑ small amount of Pour Point Depressant (PPD)
- ❑ dispersant and anti-oxidant dispersant available.

Dutral OCP

Dutral OCP grades cover a wide range of Ethylene content and Mooney Viscosity:



Dutral OCP

- Main Features of Dutral OCP Grades -

	CO 034	CO 038	CO 043	CO 058	OCP 2530 PL	OCP 5050
Ethylene (%wt)	72	72	55	52	66	52
ML 1+4(125°C)	30	60	19	55		
ML 1+4(100°C)	44	86	34	80		60
MFI (230°C / 2.16 kg) (g/10 min)					8,5	
MFI (190°C / 2.16 kg) (g/10 min)						
SSI % (1)	41	55	39	57	24	52
KV at 100°C (cSt) (1)	13,9	18,1	12,6	15,9	10,7	14,9
Thickening Efficiency (100°C) (1)	2,8	3,6	2,5	3,2	2,1	3,0
Thickening Power (100°C) (1) (cSt)	8,7	12,9	7,4	10,7	5,5	9,7
KV at 40°C (cSt) (1)	91,9	125	80,8	105,5	65,5	102,8
V.I. (1)	155	162	154	161	154	152
Physical Form	bale 25 kg in film EVA dissolvable	bale 25 kg in film EVA dissolvable	bale 25 kg in film EVA dissolvable or not wrapped	bale 25 kg in film EVA dissolvable or not wrapped	Not free flowing pellets in 20 kg PE bag	bale 25 kg in film EVA dissolvable

Notes: (1) blend 1%wt in SN150 (KV oil at 100°C = 5,25 cSt)

Dutral OCP

OCP characteristics that mainly affect lubricant properties are:

- Ethylene/Propylene ratio mainly affects Thickening Power (TP) and low temperature properties (CCS and PP)
- Molecular weight acts on Thickening Power (TP) and Permanent Shear Stability Index (PSSI)
- Molecular weight distribution has major influence on Permanent Shear Stability Index (PSSI)

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Polymer structure influence on oil performance

Polymer Structure / Application Performance	Increase in ethylene content	Increase in molecular weight	Narrowing MWD
PP	worse	no influence	no influence
PSSI	no influence	worse	improvement
TP	improvement	improvement	no influence
CCS	improvement	no influence	no influence

PP: Pour Point

PSSI: Permanent Shear Stability Index

TP: Thickening Power

CCS: Cold Cranking Simulator

MWD: Molecular weight distribution

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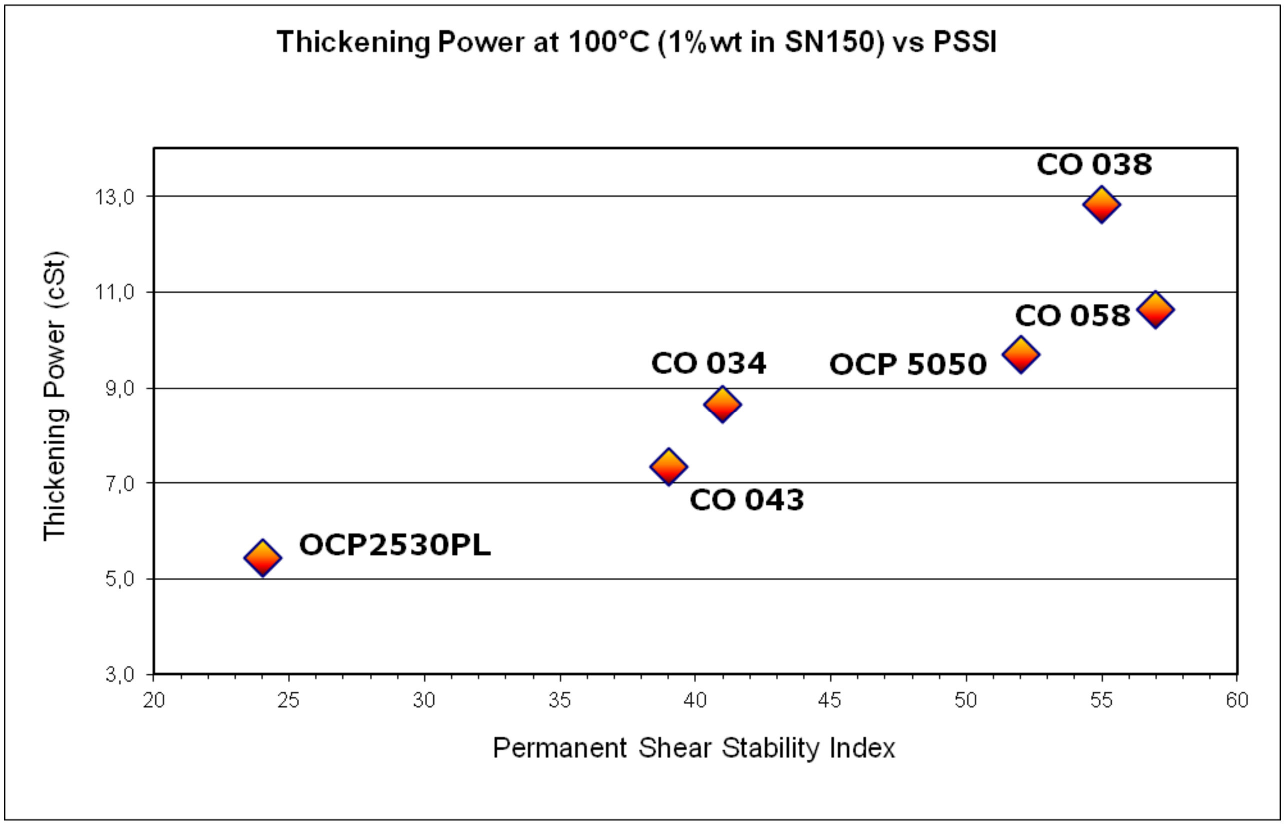
Thickening Power versus Permanent Shear Stability Index



Dutral OCP

Thickening Power (TP) grows when Permanent Shear Stability Index (PSSI) increases.

Blending polymers with low PSSI needs higher treat rate at the same KV target value.

A performance balance must be established which takes into consideration shear stability and viscosity needs.

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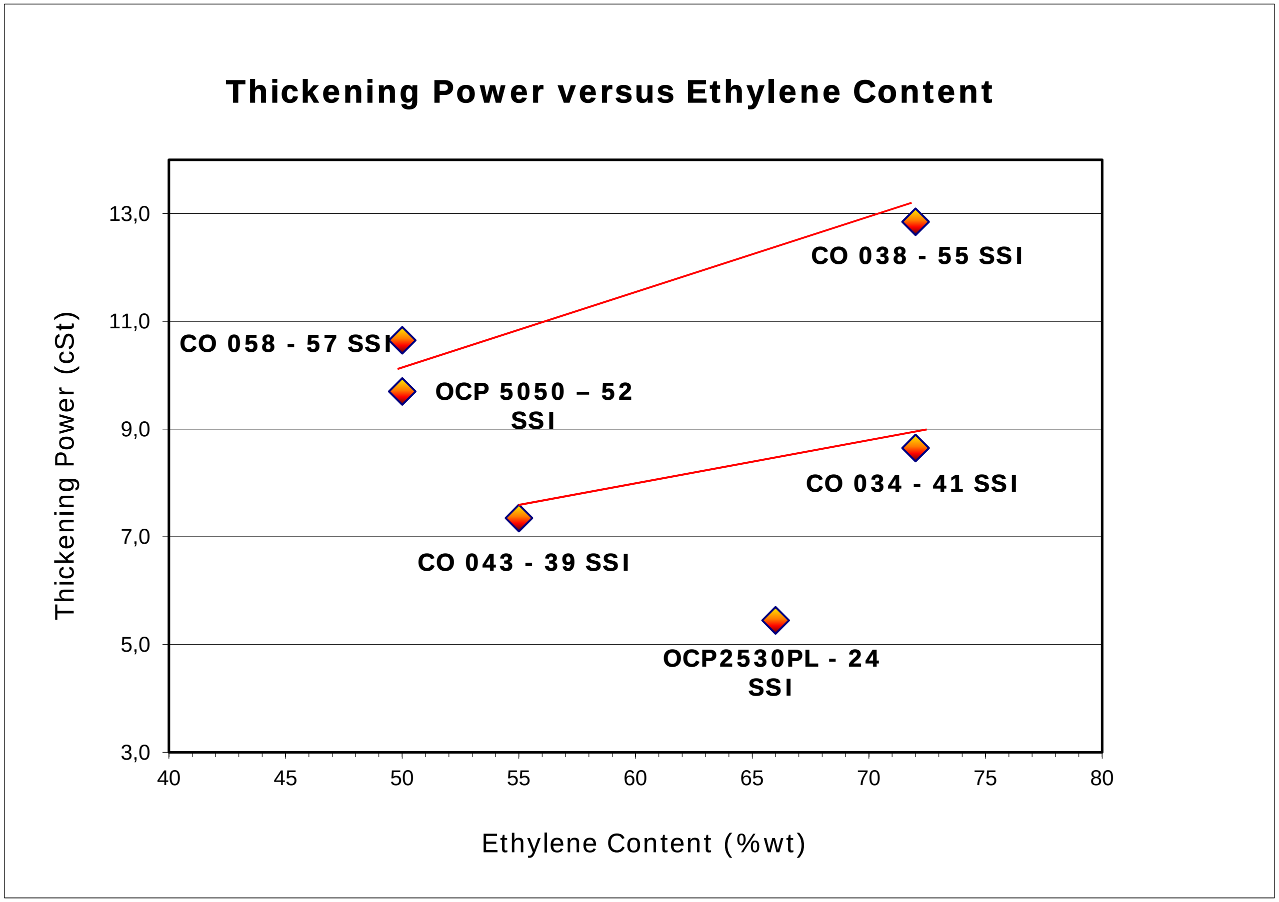
At the same PSSI value, polymers with a higher ethylene content performs a higher TP, hence treat rate is lower at the same KV target value.



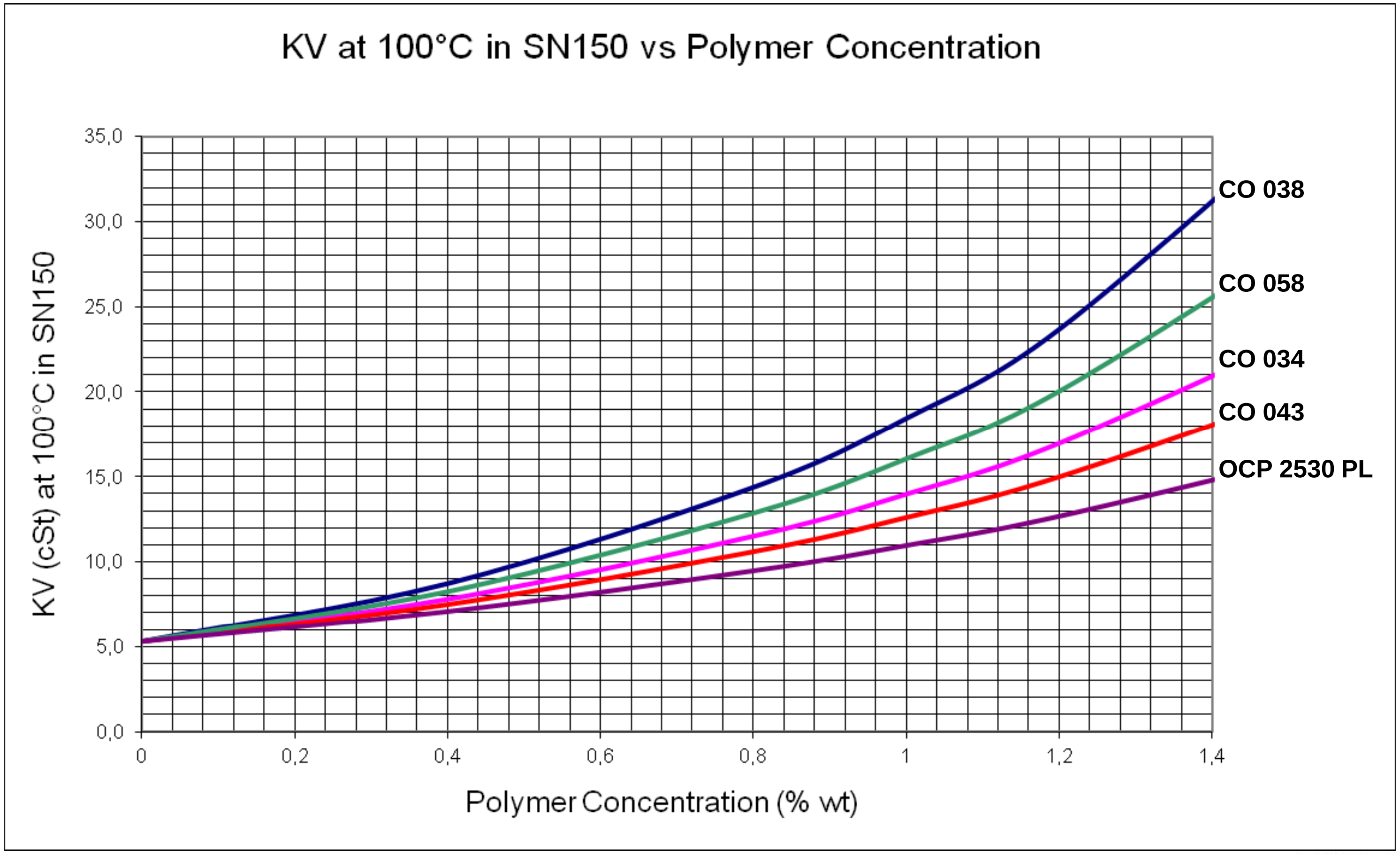
Dutral OCP

For instance in an blend in oil SN150 the TP increases of 1 cSt every 11 %wt of Ethylene content more at the same Mw. Hence using Dutral CO 038 instead of Dutral CO 058 we save more or less 10% polymer in the final formulation.

This chart could be useful to estimate the polymer treat rate in oil formulation matching a SAE grade (see Table 3).

Dutral OCP

The following curves show kinematic viscosity vs polymer concentration in SN150 oil (KV = 5,25 cSt at 100°C) for each OCP Dutral grade.



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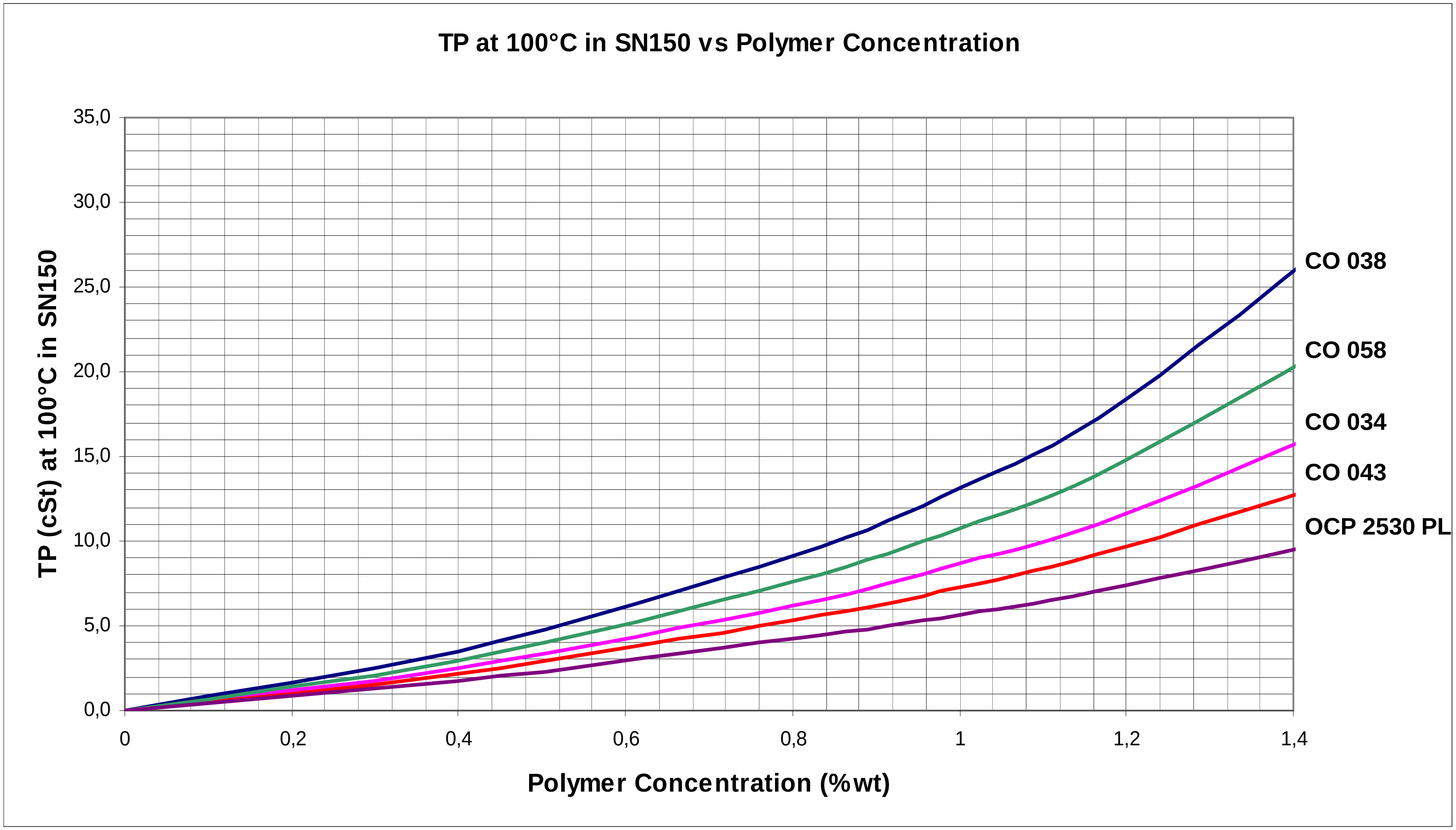
Dutral OCP

The following curves show TP vs polymer concentration in SN150 oil for each OCP Dutral grade.



Viscosity Modifiers (VM)

- Shear Stability -

The curves are calculated blending polymer in SN150. The treat rate is approximate if the finished blend (base oil + performance additive) has a KV very different from SN150.

If the wt% min is higher than %wt max that means either the polymer PSSI is too high and we need a more stable polymer grade or the base stock+additive viscosity is too low.

Below there are for each Dutral grade and SAE grade the approximate treatment.

Viscosity Modifiers (VM)

- Shear Stability -

Polymer Grade	5W30	10W30	10W40	10W50	15W40	15W50	20W40	20W50
	SAE Grade							
Dutral CO 034	0,89	0,44	0,79	-	0,54	0,78	0,22	0,53
Dutral CO 038	-	0,38	-	-	0,29	-	0,18	0,35
Dutral CO 043	0,98	0,49	0,87	-	0,60	0,86	0,24	0,59
Dutral CO 058	-	0,43	-	-	0,33	-	0,20	0,40
Dutral OCP 2530 PL	1,09	0,54	0,97	1,59	0,66	0,95	0,27	0,65

Recommended polymer treat rate (%wt) for SAE multigrade viscosity oils (1)

Note:

(1) - Approximate treating level referred to specific base stock+ additive viscosity for stay in grade