



INNOVHUB

STAZIONI SPERIMENTALI PER L'INDUSTRIA

SSOG DIVISION

PROPERTIES OF PURE GLYCEROL

Speaker Maura Sala

Milan, 18 -19 October 2012



IDENTITY CARD

NAME: GLYCEROL

C₃H₈O₃

CAS NUMBER: 56-81-5

Molar Mass: 92.08 g/mol

Via.....

Stato civile.....

Professione.....

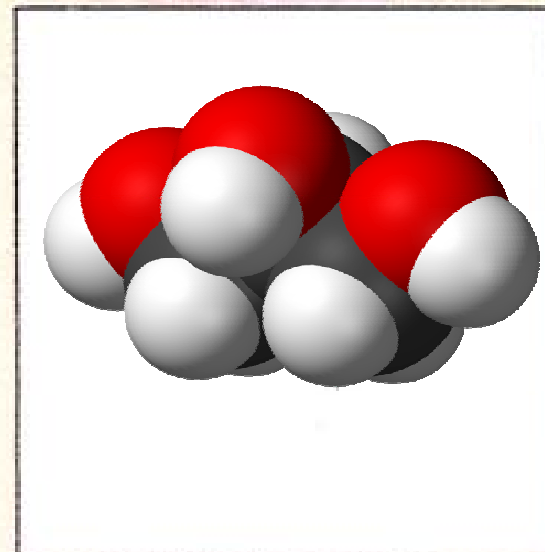
CONNOTATI E CONTRASSEGNI SALIENTI

Statura.....

Capelli.....

Occhi.....

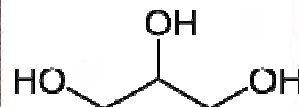
Segni particolari.....



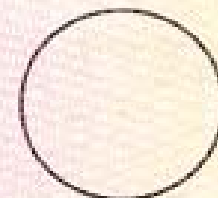
Firma del titolare.....

..... *Il*

Impronta del dito
indice sinistro



IL SINDACO



NAME SURNAME AND ... Glycerol Glycerine Glycerin

GLYCERINE (GLICERIN):

USED COMMERCIAL NAME, APPLIED TO PURIFIED COMMERCIAL PRODUCTS CONTAINING 95% OR MORE OF GLYCEROL

GLYCEROL:

REFERS TO CAS REGISTRY NUMBER: 56-81-5

CHEMICAL COMPOUND: 1,2,3 PROPANETRIOL – $\text{CH}_2\text{OHCHOHCH}_2\text{OH}$ (Trihydric alcohol: 2 primary hydroxyl group and 1 secondary group, very stable under most conditions)

EUROPE: GLYCEROL IS MUCH MORE APPLIED TERM, ALSO FOR GLYCERINE PRODUCT OR FORMULATION

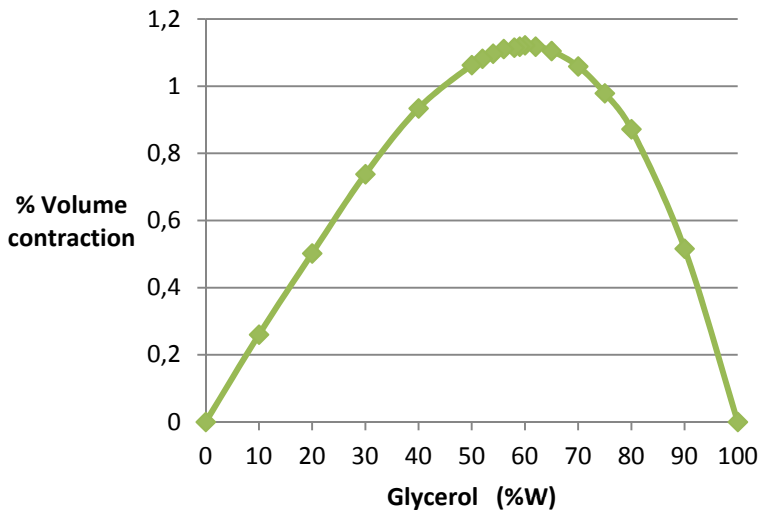


CONNOTATIONS AND MARK HIGHLIGHTS

- CLEAR
- COLORLESS
- ODORLESS
- WARM SWEET TASTE
- VISCOUS
- MISCIBLE WITH WATER AND ALCOOL
- HYGROSCOPIC
- HIGH BOILING LIQUID
- NON TOSSIC
- HIGH STABILITY UNDER ORDINARY CONDITIONS OF STORAGE AND USE
EVEN IF GLYCEROL SOLUTION, SUBJECTED TO HEAT, SHOULD NOT BE
STORED OR PROCESSED IN IRON OR COPPER CONTAINING VESSEL, UNLESS
INHIBITORS ARE PRESENT (IRON AND COPPER SALTS CATALYZE OXIDATION
OF GLYCEROL)

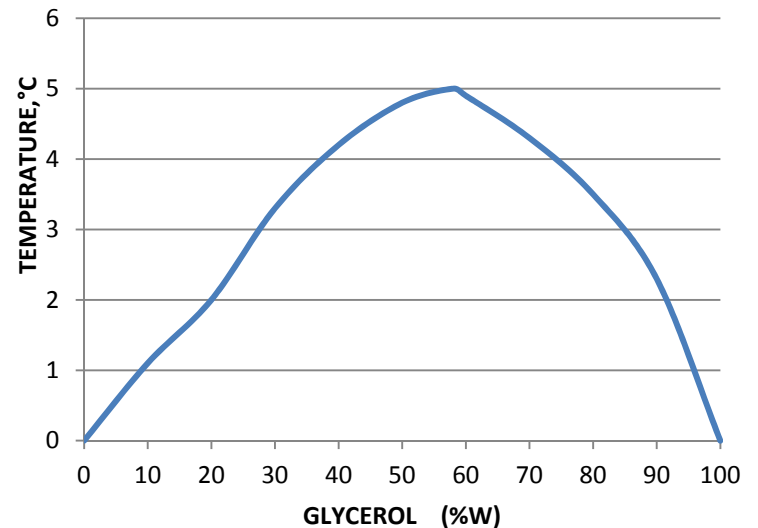
CONTRACTION VOLUME AND INCREASE OF TEMPERATURE

Volumetric contraction of glycerol and water when mixed at 20°C



The maximum increase of Temperature is 5°C at 58% (W)

Temperature rise on mixing Glycerol and water



SPECIFIC GRAVITY

BECAUSE OF THE DIFFERENCE BETWEEN THE SPECIFIC GRAVITY OR SOMETIMES IMPROPERLY CALLED “DENSITY” OF WATER AND GLYCEROL, ITS DETERMINATION HAS BEEN ONE OF THE PRINCIPAL MEANS TO ESTIMATE THE PURITY OF GLYCEROL

IN TABLE 1 DATA OF APPARENT AND TRUE SPECIFIC GRAVITY ARE AVAILABLE.

Table 1 – Specific gravity
and per cent Glycerol

(%)	15/15 °C	20/20°C	25/25 °C
100	1.26557	1.26362	1.26201
95	1.25270	1.25075	1.24910
90	1.23950	1.23755	1.23585
85	1.22620	1.22420	1.22255
80	1.21290	1.21090	1.20925
75	1.19915	1.19720	1.19565
70	1.18540	1.18355	1.18210
65	1.17155	1.16980	1.16835
60	1.15770	1.15605	1.15460
55	1.14375	1.14220	1.14090
50	1.12985	1.12845	1.12720
45	1.11620	1.11490	1.11380
40	1.10255	1.10135	1.10040
35	1.08905	1.08805	1.08715
30	1.07560	1.07470	1.07395
25	1.06250	1.06175	1.06115
20	1.04935	1.04880	1.04840
15	1.03675	1.03635	1.03605
10	1.02415	1.02395	1.02370
5	1.01210	1.01195	1.01185
1	1.00240	1.00240	1.00235
Glycerol	TRUE SPECIFIC GRAVITY		
(%)	15/15 °C	20/20°C	25/25 °C
100	1.26526	1.26331	1.26170
95	1.25240	1.25045	1.24880
90	1.23920	1.23725	1.23500
85	1.22595	1.22395	1.22230
80	1.21265	1.21065	1.20900
75	1.19890	1.19700	1.19540
70	1.18515	1.18330	1.18185
65	1.17135	1.16960	1.16815
60	1.15750	1.15585	1.15445
55	1.14360	1.14205	1.14075
50	1.12970	1.12830	1.12705
45	1.11605	1.11475	1.11365
40	1.10240	1.10125	1.10030
35	1.08895	1.08790	1.08705
30	1.07550	1.07460	1.07385
25	1.06240	1.06165	1.06110
20	1.04930	1.04875	1.04830
15	1.03670	1.03630	1.03600

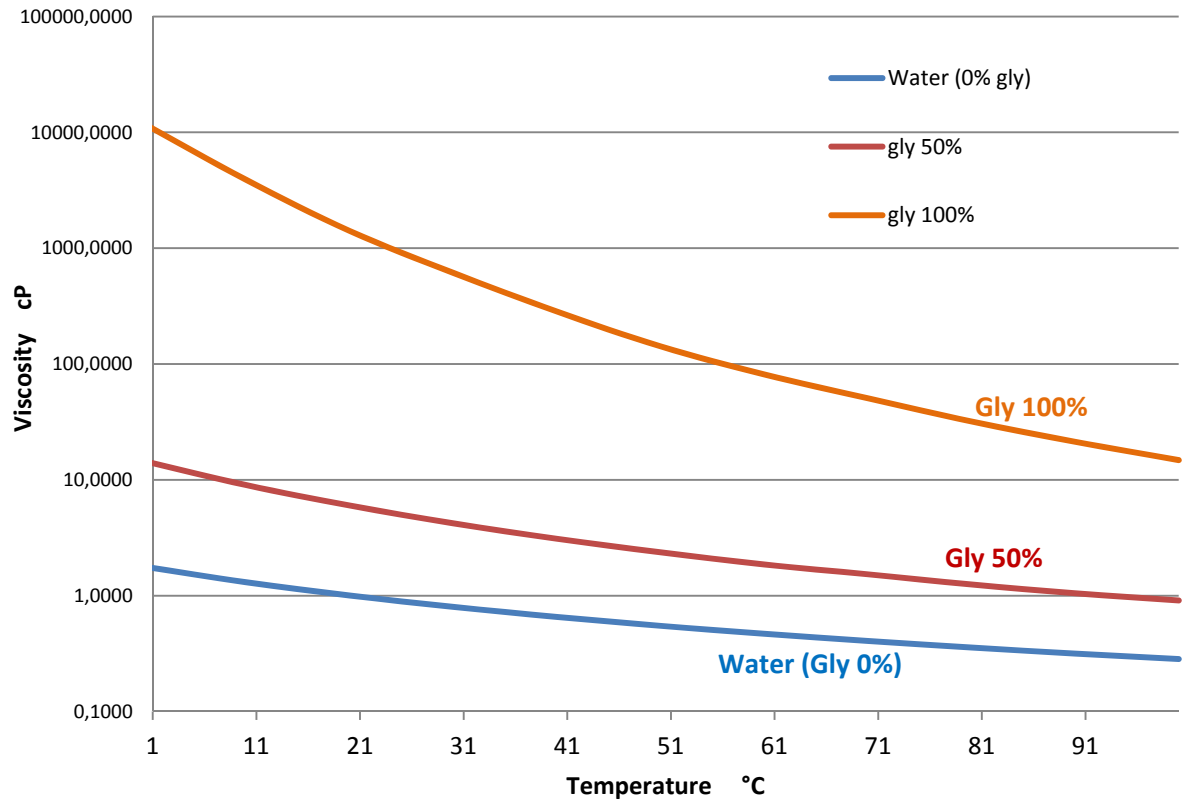
THE ACCURACY OF DETERMINATION THE SPECIFIC GRAVITY DEPENDS ON THE CONCENTRATION OF GLYCEROL, **DUE TO ITS HIGH VISCOSITY**

Glycerol (%)	DIFFERENCES (TRUE SPECIFIC GRAVITY-APPARENT SPECIFIC GRAVITY)		
	15/15 °C	20/20°C	25/25 °C
100	0,00031	0,00031	0,00031
95	0,00030	0,00030	0,00030
90	0,00030	0,00030	0,00085
85	0,00025	0,00025	0,00025
80	0,00025	0,00025	0,00025
75	0,00025	0,00020	0,00025
70	0,00025	0,00025	0,00025
65	0,00020	0,00020	0,00020
60	0,00020	0,00020	0,00015
55	0,00015	0,00015	0,00015
50	0,00015	0,00015	0,00015
45	0,00015	0,00015	0,00015
40	0,00015	0,00010	0,00010
35	0,00010	0,00015	0,00010
30	0,00010	0,00010	0,00010
25	0,00010	0,00010	0,00005
20	0,00005	0,00005	0,00010
15	0,00005	0,00005	0,00005
10	0,00000	0,00005	0,00000
5	0,00005	0,00000	0,00000
1	-	-	-

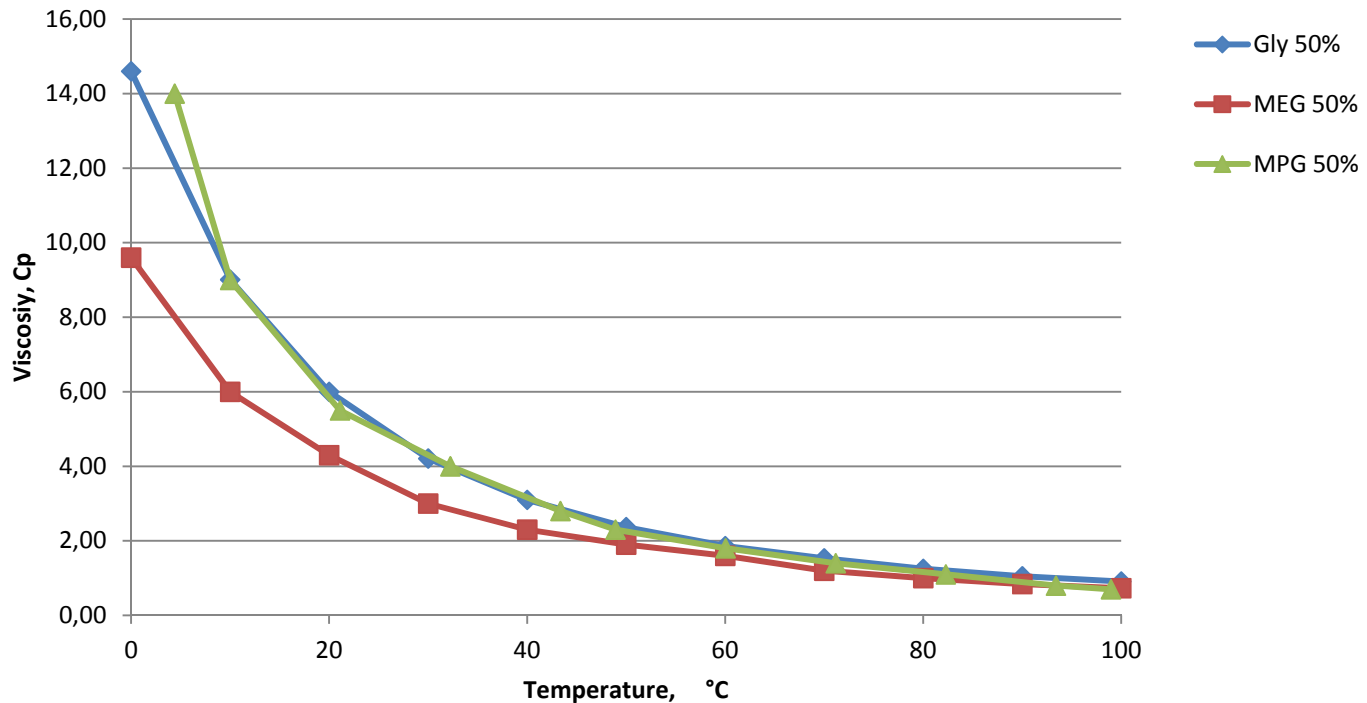


Dynamic Viscosity of Glycerol Solutions

Temperature	gly 0% (cP)	gly 50% (cP)	gly 100% (cP)
0	1,7920	14,60	12070
10	1,3080	9,01	3900
20	1,0050	6,00	1410
30	0,8007	4,21	612
40	0,6560	3,10	284
50	0,5494	2,37	142
60	0,4688	1,86	81,3
70	0,4061	1,53	50,6
80	0,3565	1,25	31,9
90	0,3165	1,05	21,3
100	0,2838	0,91	14,8

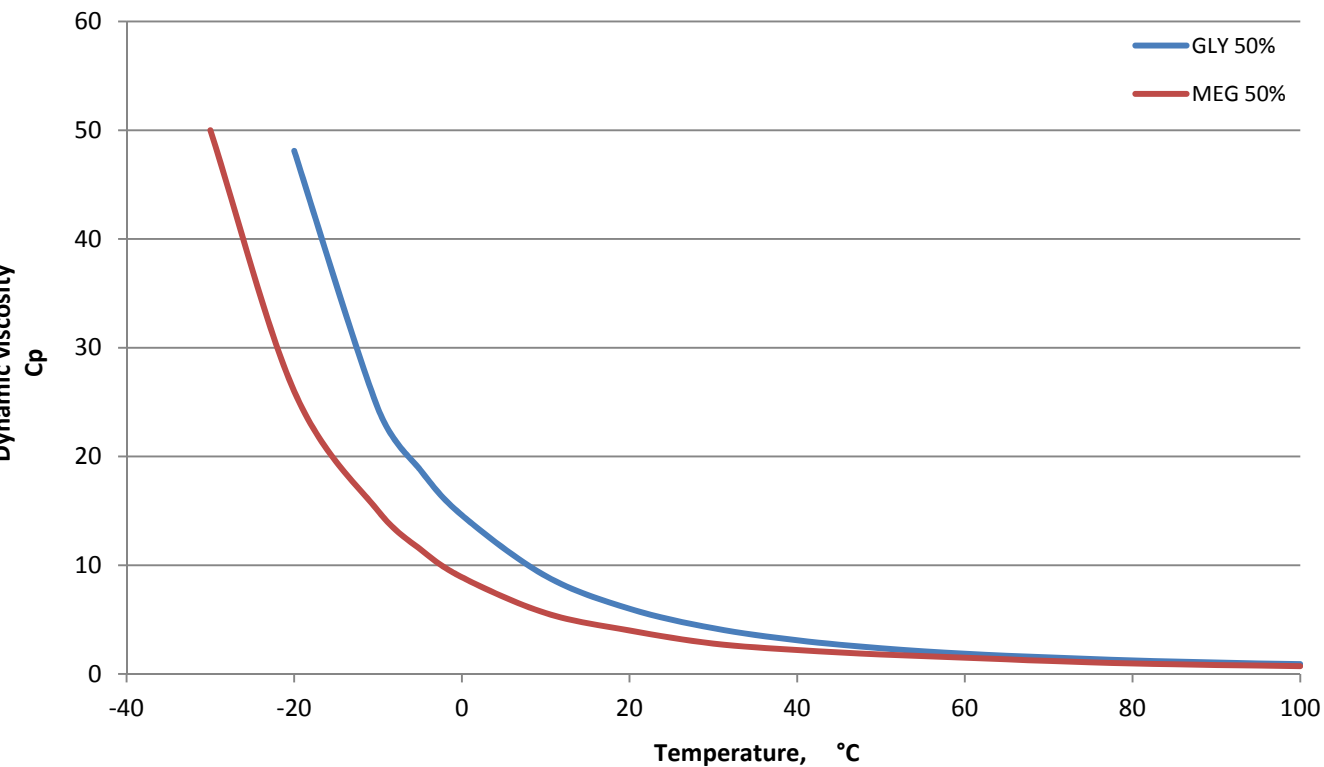


Dynamic Viscosity of Glycerol, MEG and MPG Solutions



Aqueous glycerol is similar to MPG, but more viscous than aqueous MEG solution .
At high temperature the behaviour is the same

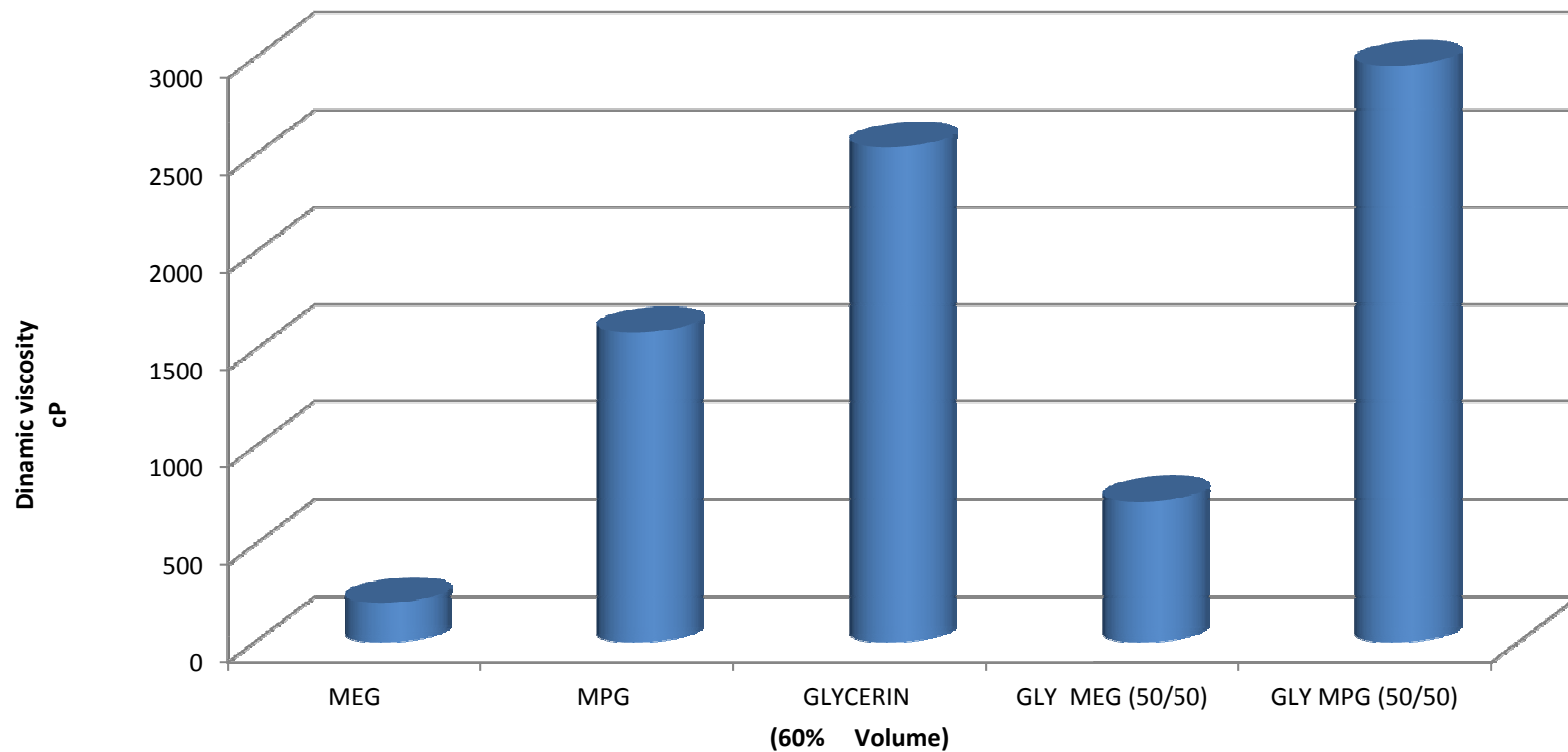
Dynamic Viscosity of Glycerol and Ethylene Solutions at low Temperature



Temp. °C	50% Gly (cP)	50%MEG (cP)
-20	48	28
-10	24,4	16
-5	18,8	12



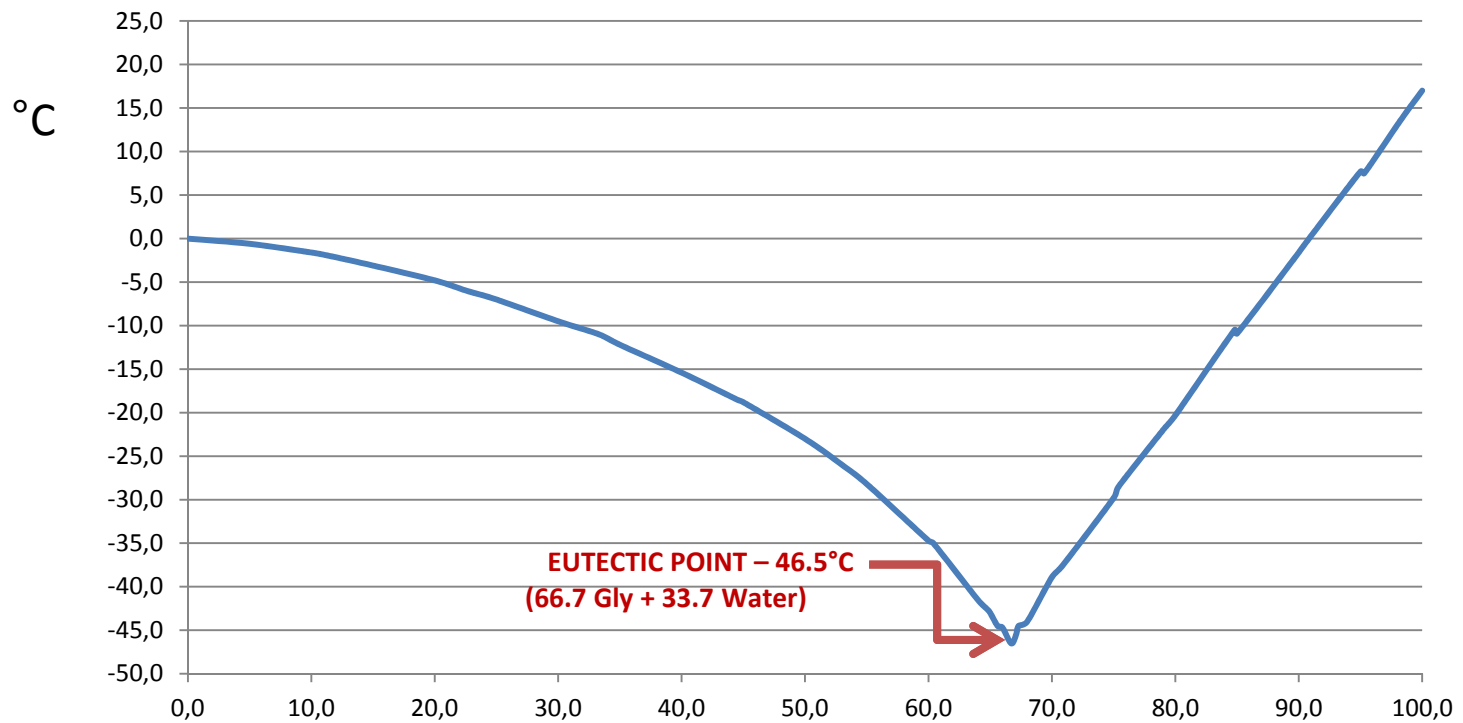
Dynamic Viscosity of Glycerol and Glycols Solutions at -40°C



Freezing point of glycerol and its solutions

Pure glycerol: + 18.0°C

Freezing point of glycerol water solutions

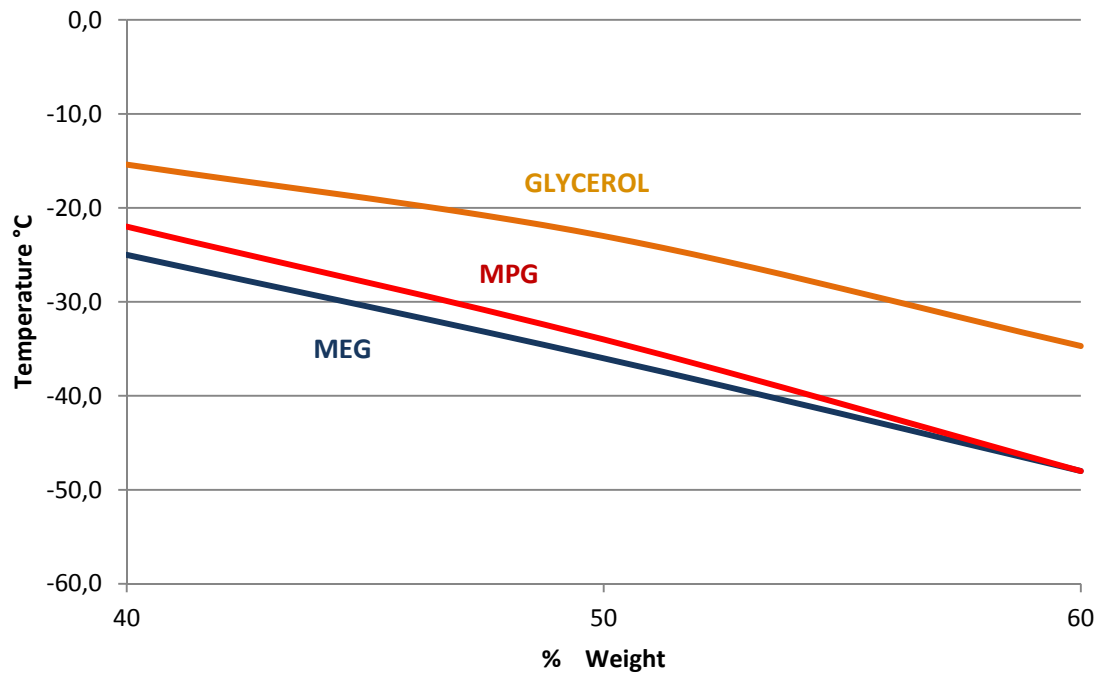


Per cent of glycerol by weight



Freezing point and Pour point of glycerol and glicols solutions

Freezing point at low temperature



Pour Point

50% Volume	°C
Mono propylen glycole	-63
Mono etylenglycole	-42
Glicerol	-51

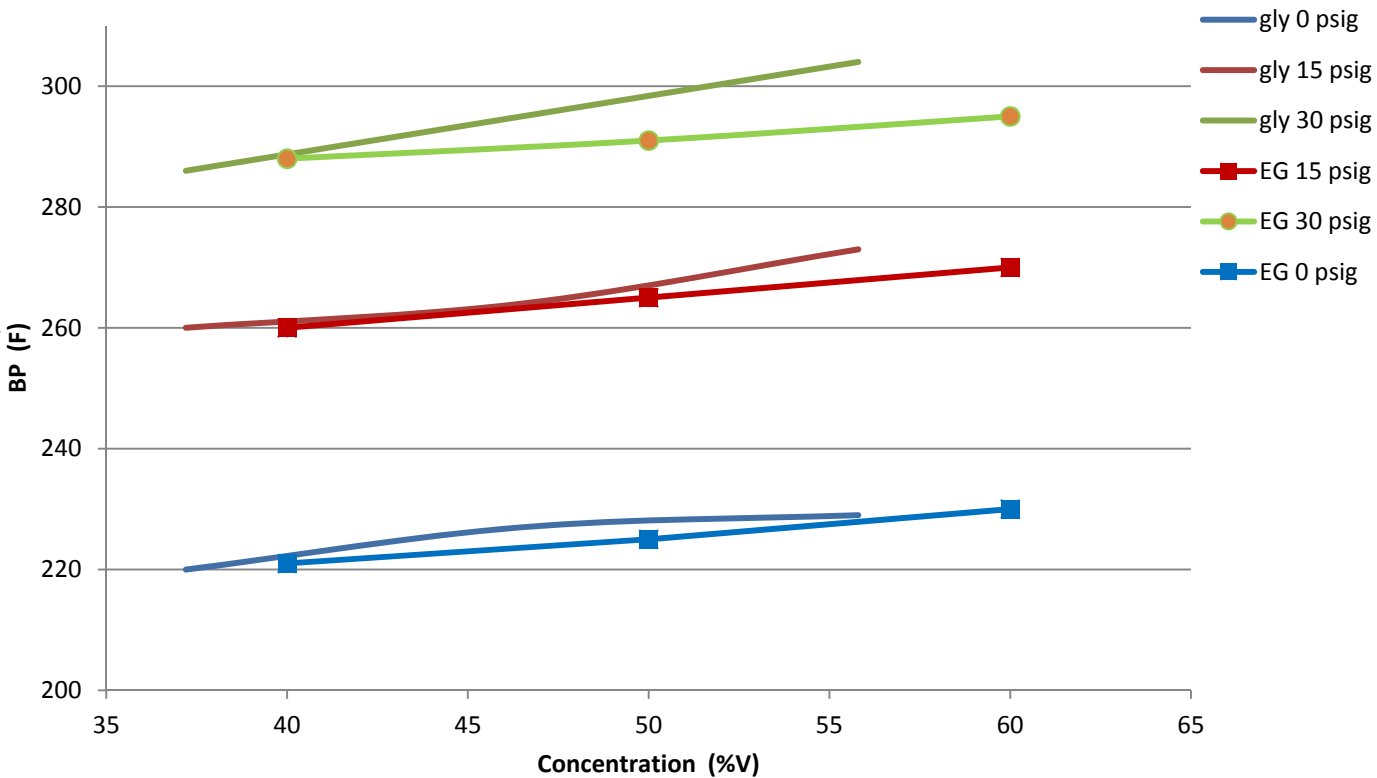
Boiling Point of Glycerol-Water solutions

Pressure (mm)	40	100	150	200	250	300	350	400	450	500	550	600	650	700	760
Pure water	34	51,6	60,1	66,4	71,6	75,9	79,6	82,9	85,9	88,7	91,2	93,5	95,7	97,7	100
Glycerol %															
10	34,4	52,1	60,7	67,0	72,3	76,6	80,3	83,7	86,7	89,5	92,0	94,3	96,6	98,6	100,9
20	34,9	52,7	61,3	67,7	73,0	77,3	81,1	84,4	87,5	90,3	92,9	95,2	97,4	99,5	101,8
30	35,5	53,4	62,1	68,6	73,8	78,2	82,0	85,3	88,4	91,3	93,8	96,2	98,4	100,4	102,8
40	36,4	54,4	63,1	69,5	74,9	79,3	83,1	86,4	89,5	92,4	95,0	97,3	99,6	101,7	104,0
50	37,5	55,7	64,5	71,1	76,4	80,9	84,8	88,2	91,3	94,2	96,8	99,2	101,5	103,6	106,0
60	39,5	58,0	66,9	73,5	79,0	83,5	87,4	90,9	94,1	97,0	99,7	102,1	104,4	106,6	109,0
70	43,0	61,7	70,8	77,6	83,1	87,7	91,7	95,2	98,4	101,4	104,1	106,6	109,0	111,1	113,6
80	49,1	68,2	77,4	84,3	90,0	94,6	98,7	102,3	105,6	108,7	11,4	113,9	116,3	118,5	121,0
90	59,5	80,2	90,3	97,7	103,9	109,1	113,5	117,4	121,0	124,4	127,4	130,2	132,8	135,2	138,0
Pure glycerol	210,0	227,3	238,6	246,8	253,6	259,2	264,3	268,2	272,1	275,7	278,8	281,8	284,6	287,1	290,0

100% Base fluid	B.P (°C)
Glycerol	290
MEG	197
MPG	188
50% Base fluid	B.P (°C)
Glycerol	106
MEG	107
MPG	106



Boiling Points of Glycerol and Glycols Solutions





SPECIFIC HEATS OF GLYCEROL-WATER MIXTURES

% GLY	Specific heat cal/g x°C
100	0,575
0,01	0,700
0,05	0,612
11,25	0,608

°C	SPECIFIC HEATS, Cal/g x °C								
	GLYCEROL								
	25%	30%	35%	40%	45%	50%	55%	60%	65%
1,7	0,88	0,87	0,86	0,84	0,82	0,80	0,77	0,74	0,71
-1,1	0,88	0,86	0,85	0,83	0,81	0,79	0,76	0,73	0,7
-3,9	0,87	0,86	0,84	0,82	0,80	0,78	0,75	0,72	0,69
-6,7	0,86	0,85	0,83	0,82	0,79	0,77	0,74	0,71	0,68
-7,2 ^a	6,8 ^a	..	..	..	..	..	..	..	..
-9,4	4,1	4,8 ^a	0,82	0,80	0,78	0,76	0,73	0,70	0,67
-12,0 ^a	..	..	3,7 ^a	..	..	..	..	..	..
-12,2	2,7	3,2	3,6	0,80	0,78	0,75	0,72	0,69	0,66
-15,0	2,1	2,4	2,7	0,79	0,77	0,74	0,71	0,67	0,65
-15,2 ^a	..	..	..	2,9 ^a	..	..	..	..	..
-17,8	1,7	1,9	2,1	2,4	0,76	0,73	0,7	0,66	0,63
-18,8 ^a	..	..	..	..	2,4 ^a	..	..	..	..
-20,6	1,4	1,6	1,8	2,0	2,2	0,72	0,69	0,65	0,62
-23,1 ^a	..	..	..	..	..	2,0 ^a	..	..	..
-23,3	1,2	1,4	1,6	1,07	1,9	2,0	0,68	0,64	0,61
-26,1	1,1	1,2	1,3	1,05	1,6	1,7	0,67	0,63	0,6
-28,3	..	..	..	..	..	..	1,7 ^a	..	..
-28,9	1,0	1,1	1,2	1,3	1,4	1,5	1,6	0,62	0,59
-31,7	0,9	1,0	1,1	1,2	1,3	1,3	1,4	0,61	0,58

a: estimated freezing point, and maximum specific heat for mixture of this composition

Convective heat transfer

The convective cooling mode is affected by four coolant fluid properties: density, specific heat, thermal conductivity and viscosity. The table below compares the properties of 100% water, 50% EG, PG and Glycerol base coolants.

Geheas, E. ("An analysis of Engine Cooling in modern passenger cars" SAE 630187 (660C, 1963, p6) states that increases in coolant density, specific heat and thermal conductivity all result in lower metal temperatures.

Comparison of convective Heat transfer related properties for fluids at 20°C				
Properties	Aqueous Solutions (50%V)			
	100% Water	MPG	MEG	Glycerol
Density, g/cm ³	1,00	1,04	1,07	1,14
Specific heat, cal/g x°C	1,00	0,84	0,78	0,77
Thermal conductivity, cal cm/s cm ² °K x 10 ⁴	14,50	8,7	10,00	9,70
Viscosity, cP	1,02	6,2	4,80	10,00

COMPARING THE THREE ANTIFREEZE/COOLANT BASE FLUID AT 50% VOLUME, THEIR FOUR CONVECTIVE HEAT TRANSFER FLUID PROPERTIES ARE SIMILAR

Flash and Fire point

The procedure is: ASTM D 92 – Cleveland open cup

99% GLYCEROL

Flash point: 177°C - Fire point: 204°C

When aqueous glycerol is tested there is not flash until the water is evaporated to bring the glycerol concentration at about 97.5%. The flash is: 190°C. This higher flash is due to the water vapors which are added to glycerol vapor. Going on to the test to the fire point the glycerol is further concentrated at about 98.6% weight. The fire point is 204°C.

	Glycerol	MEG	MPP
Flash point (°C)	177	118	99
Fire point (°C)	204	121	107
Autoignition Temperature (°C)	429	413	421

The flash point of glycerol runs about 60° higher than the glycols. Also the autoignition temperature is 10° higher:

GLYCEROL IS NOT WORSE THAN GLYCOLS FOR FLAMMABILITY PERFORMANCE



CONNOTATIONS AND MARK HIGHLIGHTS..... THANKS!

One glycerol connotation is:

WARM SWEET TASTE...

I sincerely hope that the presentation was not too “bitter” instead!

Thank you very much for your attention!

References

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