

Ethanol, 2,2,2-trifluoro-

Other names:	.beta.,.beta.,.beta.-trifluoroethyl alcohol 1,1H-perfluoroethanol 2,2,2-Trifluoroethanol 2,2,2-Trifluoroethyl alcohol CF ₃ CH ₂ OH Fluorinol 85 NSC 451 Perfluoro-1,1-dihydroethanol TFE «beta»,«beta»,«beta»-Trifluoroethyl alcohol À«betaÀ»,À«betaÀ»,À«betaÀ»-Trifluoroethyl alcohol
Inchi:	InChI=1S/C2H3F3O/c3-2(4,5)1-6/h6H,1H2
InchiKey:	RHQDFWAXVIIEBN-UHFFFAOYSA-N
Formula:	C ₂ H ₃ F ₃ O
SMILES:	OCC(F)(F)F
Mol. weight [g/mol]:	100.04
CAS:	75-89-8

Physical Properties

Property code	Value	Unit	Source
affp	700.20	kJ/mol	NIST Webbook
basg	669.90	kJ/mol	NIST Webbook
chl	-821.53 ± 0.79	kJ/mol	NIST Webbook
gf	-752.45	kJ/mol	Joback Method
hf	-833.92	kJ/mol	Joback Method
hfl	-932.57 ± 0.79	kJ/mol	NIST Webbook
hfus	6.85	kJ/mol	Joback Method
hvap	43.97	kJ/mol	NIST Webbook
ie	13.80	eV	NIST Webbook
ie	11.70	eV	NIST Webbook
ie	11.49	eV	NIST Webbook
log10ws	-0.59		Crippen Method
logp	0.541		Crippen Method
mcvol	50.220	ml/mol	McGowan Method
pc	4825.00 ± 15.00	kPa	NIST Webbook
rinpol	437.00		NIST Webbook
rinpol	441.00		NIST Webbook

rinpol	480.00		NIST Webbook
rinpol	441.00		NIST Webbook
rinpol	437.00		NIST Webbook
rinpol	441.00		NIST Webbook
tb	347.50 ± 0.50	K	NIST Webbook
tb	347.00 ± 3.00	K	NIST Webbook
tb	346.90 ± 0.20	K	NIST Webbook
tb	347.09 ± 0.25	K	NIST Webbook
tb	347.20	K	NIST Webbook
tb	351.70	K	NIST Webbook
tb	347.15	K	Vapor Pressures and Vapor-Liquid Equilibria of the 2,2,2-Trifluoroethanol + Quinoline System
tc	498.57 ± 0.10	K	NIST Webbook
tf	229.65 ± 0.30	K	NIST Webbook
vc	0.209	m3/kmol	Joback Method

Temperature Dependent Properties

Property code	Value	Unit	Temperature [K]	Source
cpg	101.07	J/mol×K	356.24	Joback Method
cpg	105.60	J/mol×K	380.55	Joback Method
cpg	109.89	J/mol×K	404.87	Joback Method
cpg	117.75	J/mol×K	453.50	Joback Method
cpg	121.35	J/mol×K	477.82	Joback Method
cpg	113.93	J/mol×K	429.19	Joback Method
cpg	96.28	J/mol×K	331.92	Joback Method
dvisc	0.0012085	Paxs	313.15	Excess Enthalpy, Excess Volume, Viscosity Deviation, and Speed of Sound Deviation for the Mixture Tetrahydrofuran + 2,2,2-Trifluoroethanol at (283.15, 298.15, and 313.15) K

dvisc	0.0026931	Paxs	283.15	Excess Enthalpy, Excess Volume, Viscosity Deviation, and Speed of Sound Deviation for the Mixture Tetrahydropyran + 2,2,2-Trifluoroethanol at (283.15, 298.15, and 313.15) K
dvisc	0.0017546	Paxs	298.15	Excess Enthalpy, Excess Volume, Viscosity Deviation, and Speed of Sound Deviation for the Mixture Tetrahydropyran + 2,2,2-Trifluoroethanol at (283.15, 298.15, and 313.15) K
dvisc	0.0012085	Paxs	313.15	Excess Enthalpy, Excess Volume, Viscosity Deviation, and Speed of Sound Deviation for the Mixture Tetrahydropyran + 2,2,2-Trifluoroethanol at (283.15, 298.15, and 313.15) K
dvisc	0.0017548	Paxs	298.15	Excess Enthalpy, Excess Volume, Viscosity Deviation, and Speed of Sound Deviation for the Mixture Tetrahydrofuran + 2,2,2-Trifluoroethanol at (283.15, 298.15, and 313.15) K
dvisc	0.0026935	Paxs	283.15	Excess Enthalpy, Excess Volume, Viscosity Deviation, and Speed of Sound Deviation for the Mixture Tetrahydrofuran + 2,2,2-Trifluoroethanol at (283.15, 298.15, and 313.15) K

hvapt	45.90	kJ/mol	289.00	NIST Webbook
hvapt	44.00	kJ/mol	313.00	NIST Webbook
hvapt	41.50	kJ/mol	313.00	NIST Webbook
hvapt	44.50	kJ/mol	285.50	NIST Webbook
pvap	100.80	kPa	346.65	Vapor Pressure Measurement for the Water + 1,3-Dimethylimidazolium Chloride System and 2,2,2-Trifluoroethanol + 1-Ethyl-3-methylimidazolium Tetrafluoroborate System
pvap	87.31	kPa	343.15	Vapor Pressure Measurement for the Water + 1,3-Dimethylimidazolium Chloride System and 2,2,2-Trifluoroethanol + 1-Ethyl-3-methylimidazolium Tetrafluoroborate System
pvap	36.10	kPa	323.15	Vapor Pressure Measurement for the Water + 1,3-Dimethylimidazolium Chloride System and 2,2,2-Trifluoroethanol + 1-Ethyl-3-methylimidazolium Tetrafluoroborate System
pvap	21.83	kPa	313.15	Vapor Pressure Measurement for the Water + 1,3-Dimethylimidazolium Chloride System and 2,2,2-Trifluoroethanol + 1-Ethyl-3-methylimidazolium Tetrafluoroborate System
pvap	12.82	kPa	303.15	Vapor Pressure Measurement for the Water + 1,3-Dimethylimidazolium Chloride System and 2,2,2-Trifluoroethanol + 1-Ethyl-3-methylimidazolium Tetrafluoroborate System

pvap	7.25	kPa	293.15	Vapor Pressure Measurement for the Water + 1,3-Dimethylimidazolium Chloride System and 2,2,2-Trifluoroethanol + 1-Ethyl-3-methylimidazolium Tetrafluoroborate System
pvap	57.08	kPa	333.15	Vapor Pressure Measurement for the Water + 1,3-Dimethylimidazolium Chloride System and 2,2,2-Trifluoroethanol + 1-Ethyl-3-methylimidazolium Tetrafluoroborate System
pvap	3.96	kPa	283.15	Vapor Pressure Measurement for the Water + 1,3-Dimethylimidazolium Chloride System and 2,2,2-Trifluoroethanol + 1-Ethyl-3-methylimidazolium Tetrafluoroborate System
rhol	1391.10	kg/m3	293.15	Calorimetric and Volumetric Study on Binary Mixtures 2,2,2-Trifluoroethanol + (1-Butyl-3-methylimidazolium Tetrafluoroborate or 1-Ethyl-3-methylimidazolium Tetrafluoroborate)
rhol	1373.80	kg/m3	303.15	Calorimetric and Volumetric Study on Binary Mixtures 2,2,2-Trifluoroethanol + (1-Butyl-3-methylimidazolium Tetrafluoroborate or 1-Ethyl-3-methylimidazolium Tetrafluoroborate)

rhol	1389.70	kg/m3	293.14	Calorimetric and Volumetric Study on Binary Mixtures 2,2,2-Trifluoroethanol + (1-Butyl-3-methylimidazolium Tetrafluoroborate or 1-Ethyl-3-methylimidazolium Tetrafluoroborate)
rhol	1356.10	kg/m3	313.15	Calorimetric and Volumetric Study on Binary Mixtures 2,2,2-Trifluoroethanol + (1-Butyl-3-methylimidazolium Tetrafluoroborate or 1-Ethyl-3-methylimidazolium Tetrafluoroborate)
rhol	1354.80	kg/m3	313.15	Calorimetric and Volumetric Study on Binary Mixtures 2,2,2-Trifluoroethanol + (1-Butyl-3-methylimidazolium Tetrafluoroborate or 1-Ethyl-3-methylimidazolium Tetrafluoroborate)
rhol	1338.00	kg/m3	323.15	Calorimetric and Volumetric Study on Binary Mixtures 2,2,2-Trifluoroethanol + (1-Butyl-3-methylimidazolium Tetrafluoroborate or 1-Ethyl-3-methylimidazolium Tetrafluoroborate)
rhol	1336.60	kg/m3	323.15	Calorimetric and Volumetric Study on Binary Mixtures 2,2,2-Trifluoroethanol + (1-Butyl-3-methylimidazolium Tetrafluoroborate or 1-Ethyl-3-methylimidazolium Tetrafluoroborate)

rhol	1319.10	kg/m3	333.15	Calorimetric and Volumetric Study on Binary Mixtures 2,2,2-Trifluoroethanol + (1-Butyl-3-methylimidazolium Tetrafluoroborate or 1-Ethyl-3-methylimidazolium Tetrafluoroborate)
rhol	1317.80	kg/m3	333.15	Calorimetric and Volumetric Study on Binary Mixtures 2,2,2-Trifluoroethanol + (1-Butyl-3-methylimidazolium Tetrafluoroborate or 1-Ethyl-3-methylimidazolium Tetrafluoroborate)
rhol	1382.40	kg/m3	298.15	Liquid-Liquid Equilibrium for 2,2,2-Trifluoroethanol + Ethanol + Cyclohexane from (288.15 to 308.15) K
rhol	1382.40	kg/m3	298.15	Liquid-Liquid Equilibrium of (Cyclohexane + 2,2,2-Trifluoroethanol) and (Cyclohexane + Methanol) from (278.15 to 318.15) K
rhol	1382.40	kg/m3	298.15	Effect of Temperature on Phase Equilibrium of the Mixed-Solvent System of (2,2,2-Trifluoroethanol + Methanol + Cyclohexane)
rhol	1408.20	kg/m3	283.15	Calorimetric and Volumetric Study on Binary Mixtures 2,2,2-Trifluoroethanol + (1-Butyl-3-methylimidazolium Tetrafluoroborate or 1-Ethyl-3-methylimidazolium Tetrafluoroborate)

rhol	1383.41	kg/m3	298.15	Thermodynamic properties of binary mixtures of 2,2,2-Trifluoroethanol with Water or Alkanols at T=298.15 K
rhol	1320.70	kg/m3	333.15	Density and viscosity of three (2,2,2-trifluoroethanol + 1-butyl-3-methylimidazolium) ionic liquid binary systems
rhol	1330.10	kg/m3	328.15	Density and viscosity of three (2,2,2-trifluoroethanol + 1-butyl-3-methylimidazolium) ionic liquid binary systems
rhol	1339.40	kg/m3	323.15	Density and viscosity of three (2,2,2-trifluoroethanol + 1-butyl-3-methylimidazolium) ionic liquid binary systems
rhol	1348.50	kg/m3	318.15	Density and viscosity of three (2,2,2-trifluoroethanol + 1-butyl-3-methylimidazolium) ionic liquid binary systems
rhol	1357.40	kg/m3	313.15	Density and viscosity of three (2,2,2-trifluoroethanol + 1-butyl-3-methylimidazolium) ionic liquid binary systems
rhol	1366.20	kg/m3	308.15	Density and viscosity of three (2,2,2-trifluoroethanol + 1-butyl-3-methylimidazolium) ionic liquid binary systems
rhol	1374.90	kg/m3	303.15	Density and viscosity of three (2,2,2-trifluoroethanol + 1-butyl-3-methylimidazolium) ionic liquid binary systems

rhol	1383.40	kg/m3	298.15	Density and viscosity of three (2,2,2-trifluoroethanol + 1-butyl-3-methylimidazolium) ionic liquid binary systems
rhol	1391.80	kg/m3	293.15	Density and viscosity of three (2,2,2-trifluoroethanol + 1-butyl-3-methylimidazolium) ionic liquid binary systems
rhol	1400.20	kg/m3	288.15	Density and viscosity of three (2,2,2-trifluoroethanol + 1-butyl-3-methylimidazolium) ionic liquid binary systems
rhol	1408.50	kg/m3	283.15	Density and viscosity of three (2,2,2-trifluoroethanol + 1-butyl-3-methylimidazolium) ionic liquid binary systems
rhol	1416.60	kg/m3	278.15	Density and viscosity of three (2,2,2-trifluoroethanol + 1-butyl-3-methylimidazolium) ionic liquid binary systems
rhol	1382.40	kg/m3	298.15	Phase diagrams of (hexane + methanol + 2,2,2-trifluoroethanol) at three temperatures: Measurement and correlation
rhol	1382.40	kg/m3	298.15	Volumetric properties of binary and ternary mixtures of diisopropyl ether, a,a,a-trifluorotoluene, 2,2,2-trifluoroethanol, and ethanol at a temperature 298.15 K and pressure 101 kPa

rhol	1372.40	kg/m3	303.19	Calorimetric and Volumetric Study on Binary Mixtures 2,2,2-Trifluoroethanol + (1-Butyl-3-methylimidazolium Tetrafluoroborate or 1-Ethyl-3-methylimidazolium Tetrafluoroborate)
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Pressure Dependent Properties

Property code	Value	Unit	Pressure [kPa]	Source
tbp	347.40	K	102.00	Experimental Isobaric Vapor-Liquid Equilibria of Binary Mixtures of 2,2,2-Trifluoroethanol with Benzene or Toluene
tbp	347.40	K	102.00	Study of Vapor-Liquid Equilibrium for Binary Mixtures (Chloroform + 2,2,2-Trifluoroethanol) and (r,r,r-Trifluorotoluene + 2,2,2-Trifluoroethanol) at Pressure 102 kPa

Correlations

Information	Value
Property code	pvap
Equation	$\ln(P_{\text{vp}}) = A + B/(T + C)$
Coeff. A	1.56334e+01
Coeff. B	-3.05802e+03
Coeff. C	-6.95280e+01
Temperature range (K), min.	268.80
Temperature range (K), max.	365.79

Datasets

Viscosity, Pa*s

Temperature, K - Liquid	Pressure, kPa - Liquid	Viscosity, Pa*s - Liquid
263.15	100.00	0.0055020
263.15	100.00	0.0054850
263.15	9900.00	0.0061250
263.15	10000.00	0.0061340
263.15	24500.00	0.0071590
263.15	24600.00	0.0071680
263.15	50500.00	0.0092120
263.15	50600.00	0.0092030
263.15	75500.00	0.0115200
263.15	75500.00	0.0115100
263.15	100200.00	0.0142800
263.15	101000.00	0.0143800
263.15	131600.00	0.0184000
263.15	132200.00	0.0185300
268.15	100.00	0.0045170
268.15	100.00	0.0045130
322.14	10500.00	0.0011250
322.14	10500.00	0.0011280
322.14	25500.00	0.0012860
322.14	25500.00	0.0012860
322.14	50500.00	0.0015610
322.14	50500.00	0.0015610
322.14	75000.00	0.0018270
322.14	75200.00	0.0018280
322.14	100300.00	0.0021370
322.14	100300.00	0.0021370
323.15	100.00	0.0009974
323.15	100.00	0.0009890
323.15	100.00	0.0009965
323.15	100.00	0.0010020
323.15	100.00	0.0009797
323.15	100.00	0.0009841
273.15	100.00	0.0038070

273.15	100.00	0.0038050
273.15	100.00	0.0037800
273.15	100.00	0.0037770
273.15	100.00	0.0037980
273.15	100.00	0.0037980
273.15	10400.00	0.0042260
273.15	10500.00	0.0042240
273.15	25500.00	0.0049090
273.15	25500.00	0.0049050
273.15	50500.00	0.0061790
273.15	50500.00	0.0061660
273.15	75000.00	0.0075700
273.15	75500.00	0.0075820
273.15	99800.00	0.0093730
273.15	100300.00	0.0093750
273.15	125600.00	0.0113700
273.15	125600.00	0.0114500
273.15	125700.00	0.0113900
273.15	150300.00	0.0137300
273.15	150700.00	0.0137900
273.15	176200.00	0.0165300
273.15	176400.00	0.0166100
273.15	201100.00	0.0196000
273.15	201100.00	0.0195100
273.15	233500.00	0.0242500
273.15	233700.00	0.0242900
323.15	100.00	0.0009797
323.15	100.00	0.0009829
323.15	100.00	0.0009933
323.15	100.00	0.0009884
323.15	10000.00	0.0010910
323.15	10100.00	0.0010900
323.15	25300.00	0.0012460
323.15	25400.00	0.0012480
323.15	49500.00	0.0014920
323.15	49700.00	0.0014930
323.15	74800.00	0.0017810
323.15	75000.00	0.0017890
323.15	99900.00	0.0020750
323.15	100000.00	0.0020730
323.15	100400.00	0.0020960
323.15	100400.00	0.0020930
323.15	125000.00	0.0023960
323.15	125400.00	0.0023950

323.15	150100.00	0.0027370
323.15	150500.00	0.0027380
323.15	176000.00	0.0031310
323.15	176000.00	0.0031310
323.15	200300.00	0.0036540
323.15	200800.00	0.0036510
323.15	210100.00	0.0038370
323.15	210100.00	0.0038490
323.15	225200.00	0.0041340
278.15	100.00	0.0033110
278.15	100.00	0.0033050
283.15	100.00	0.0027460
283.15	100.00	0.0027490
288.15	100.00	0.0023630
288.15	100.00	0.0023680
293.15	100.00	0.0020540
293.15	100.00	0.0020470
293.15	100.00	0.0020770
293.15	100.00	0.0020790
298.15	100.00	0.0017810
298.15	100.00	0.0017820
298.15	100.00	0.0017860
298.15	100.00	0.0017870
298.15	100.00	0.0017790
298.15	100.00	0.0017670
298.15	100.00	0.0017820
298.15	100.00	0.0017740
298.15	10200.00	0.0019800
298.15	10200.00	0.0019810
298.15	25400.00	0.0022670
298.15	25400.00	0.0022640
298.15	49900.00	0.0027550
298.15	50200.00	0.0027730
298.15	74900.00	0.0033170
298.15	75100.00	0.0033140
298.15	100400.00	0.0039290
323.15	225300.00	0.0041310
323.15	226700.00	0.0040280
323.15	227900.00	0.0040580
323.15	248900.00	0.0046000
323.15	249400.00	0.0046140
323.15	275300.00	0.0051920
323.15	275600.00	0.0052090
323.15	300600.00	0.0058340

323.15	301200.00	0.0058530
323.15	325600.00	0.0065090
323.15	326200.00	0.0065620
323.15	347900.00	0.0071870
323.15	349200.00	0.0072070
328.15	100.00	0.0008939
328.15	100.00	0.0008974
333.15	100.00	0.0008117
333.15	100.00	0.0008117
338.15	100.00	0.0007379
338.15	100.00	0.0007382
343.15	100.00	0.0006739
343.15	100.00	0.0006739
343.15	100.00	0.0006710
343.15	100.00	0.0006718
343.15	100.00	0.0006660
343.15	100.00	0.0006657
343.15	10500.00	0.0007504
343.15	10500.00	0.0007498
298.15	100600.00	0.0039380
298.15	125200.00	0.0046120
298.15	125400.00	0.0046100
298.15	150100.00	0.0053470
298.15	150100.00	0.0053470
298.15	175000.00	0.0061980
298.15	175200.00	0.0061970
298.15	197500.00	0.0069650
298.15	197800.00	0.0069930
298.15	200700.00	0.0072100
298.15	201700.00	0.0072970
298.15	224400.00	0.0082540
298.15	226100.00	0.0083300
298.15	256900.00	0.0099310
298.15	258400.00	0.0100300
298.15	276700.00	0.0109800
298.15	277800.00	0.0110400
298.15	300600.00	0.0123000
298.15	301600.00	0.0124300
298.15	325400.00	0.0139900
298.15	326500.00	0.0140600
298.15	348800.00	0.0157700
298.15	351100.00	0.0159500
303.15	100.00	0.0015740
303.15	100.00	0.0015650

308.15	100.00	0.0013840
308.15	100.00	0.0013840
343.15	25500.00	0.0008438
343.15	50000.00	0.0010160
343.15	50000.00	0.0010160
343.15	76400.00	0.0012290
343.15	76400.00	0.0012280
343.15	99900.00	0.0014250
343.15	100500.00	0.0014110
343.15	100700.00	0.0014190
343.15	100700.00	0.0014160
343.15	100900.00	0.0014210
343.15	125800.00	0.0016660
343.15	126100.00	0.0016600
343.15	150000.00	0.0018940
343.15	150200.00	0.0018990
343.15	175300.00	0.0021410
343.15	175600.00	0.0021490
343.15	200400.00	0.0023970
343.15	200700.00	0.0024090
343.15	225200.00	0.0026440
343.15	225400.00	0.0026720
343.15	249500.00	0.0029240
343.15	249800.00	0.0029350
343.15	276600.00	0.0032590
343.15	277100.00	0.0032770
343.15	300300.00	0.0035700
343.15	301200.00	0.0035960
343.15	325100.00	0.0039100
313.15	100.00	0.0012190
313.15	100.00	0.0012210
318.15	100.00	0.0010810
318.15	100.00	0.0010780
343.15	325600.00	0.0039390
343.15	350100.00	0.0043060
343.15	352100.00	0.0043760

Reference

<https://www.doi.org/10.1021/acs.jced.7b01030>

Mass density, kg/m³

Pressure, kPa - Liquid

Temperature, K - Liquid

Mass density, kg/m³ - Liquid

100.00	288.15	1400.0
1000.00	288.15	1401.0
5000.00	288.15	1407.0
10000.00	288.15	1415.0
15000.00	288.15	1422.0
20000.00	288.15	1428.0
25000.00	288.15	1435.0
30000.00	288.15	1441.0
35000.00	288.15	1447.0
40000.00	288.15	1453.0
100.00	293.15	1391.0
1000.00	293.15	1393.0
5000.00	293.15	1399.0
10000.00	293.15	1407.0
15000.00	293.15	1414.0
20000.00	293.15	1421.0
25000.00	293.15	1427.0
30000.00	293.15	1434.0
35000.00	293.15	1440.0
40000.00	293.15	1446.0
100.00	303.15	1374.0
1000.00	303.15	1375.0
5000.00	303.15	1382.0
10000.00	303.15	1390.0
15000.00	303.15	1398.0
20000.00	303.15	1405.0
25000.00	303.15	1412.0
30000.00	303.15	1419.0
35000.00	303.15	1425.0
40000.00	303.15	1431.0
100.00	313.15	1356.0
1000.00	313.15	1358.0
5000.00	313.15	1365.0
10000.00	313.15	1374.0
15000.00	313.15	1382.0
20000.00	313.15	1390.0
25000.00	313.15	1397.0
30000.00	313.15	1404.0
35000.00	313.15	1411.0
40000.00	313.15	1417.0
100.00	323.15	1338.0
1000.00	323.15	1340.0
5000.00	323.15	1348.0
10000.00	323.15	1357.0

15000.00	323.15	1365.0
20000.00	323.15	1374.0
25000.00	323.15	1381.0
30000.00	323.15	1389.0
35000.00	323.15	1396.0
40000.00	323.15	1402.0
100.00	333.15	1319.0
1000.00	333.15	1321.0
5000.00	333.15	1330.0
10000.00	333.15	1339.0
15000.00	333.15	1349.0
20000.00	333.15	1357.0
25000.00	333.15	1365.0
30000.00	333.15	1373.0
35000.00	333.15	1380.0
40000.00	333.15	1388.0

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Legend

affp:	Proton affinity
basg:	Gas basicity
chl:	Standard liquid enthalpy of combustion
cpg:	Ideal gas heat capacity
dvisc:	Dynamic viscosity
gf:	Standard Gibbs free energy of formation
hf:	Enthalpy of formation at standard conditions
hfl:	Liquid phase enthalpy of formation at standard conditions
hfus:	Enthalpy of fusion at standard conditions
hvap:	Enthalpy of vaporization at standard conditions
hvapt:	Enthalpy of vaporization at a given temperature
ie:	Ionization energy
log10ws:	Log10 of Water solubility in mol/l
logp:	Octanol/Water partition coefficient
mcvol:	McGowan's characteristic volume
pc:	Critical Pressure
pvap:	Vapor pressure
rhol:	Liquid Density
rinpol:	Non-polar retention indices
tb:	Normal Boiling Point Temperature
tbp:	Boiling point at given pressure
tc:	Critical Temperature
tf:	Normal melting (fusion) point
vc:	Critical Volume

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<https://www.chemeo.com/cid/16-714-1/Ethanol-2-2-2-trifluoro.pdf>

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