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ITTC 1963 10 <sup>th</sup> pp 288 - 294	10 <sup>th</sup> ITTC 1963
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## 1. DENSITY AND VISCOSITY OF FRESH WATER AND SEA WATER

### 1.1 Formulae Used by 1978 ITTC Performance Prediction Method:

#### Density of fresh water

$$\rho = 1000 \text{ kg / m}^3$$

#### Viscosity of fresh water:

$$\nu_0 = ((0.585 \cdot 10^{-3} \cdot (T - 12.0) - 0.03361) \cdot (T - 12.0) + 1.2350) \cdot 10^{-6}$$

#### Density of sea water

$$\rho = 1025 \text{ kg / m}^3$$

#### Viscosity of sea water:

$$\nu_s = ((0.659 \cdot 10^{-3} \cdot (T - 1.0) - 0.05076) \cdot (T - 1.0) + 1.7688) \cdot 10^{-6}$$


With  $T$  water temperature in °C.

### 1.2 Formula Given in 1963:

#### Formula by Hardy for viscosity of salt water

$$\mu_s = \frac{K}{1 + 0.03338T + 0.00018325T^2} \cdot \mu_0 \quad \text{Where}$$

$K = 1.052$ ,  $\mu_s$  is the viscosity of seawater at  $T^\circ \text{C}$  and  $\mu_0 = 0.01787$  poise that of fresh water at  $0^\circ \text{C}$

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### 1.3 Tables Given In 1963

TABLE 1

#### Values of Mass Density for Fresh Water

Temperature in degrees Centigrade

$\rho$  in metric units of  $\frac{\text{kg s}^{-2}}{\text{m}^3}$

$^{\circ}\text{C}$	$\rho$	$^{\circ}\text{C}$	$\rho$
0	101.95	16	101.86
1	101.95	17	101.84
2	101.96	18	101.82
3	101.96	19	101.80
4	101.96	20	101.78
5	101.96	21	101.76
6	101.96	22	101.74
7	101.95	23	101.71
8	101.95	24	101.69
9	101.94	25	101.66
10	101.93	26	101.64
11	101.92	27	101.61
12	101.91	28	101.58
13	101.90	29	101.55
14	101.88	30	101.52
15	101.87		


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TABLE 2

**Values of Mass Density for Salt Water**

Temperature in degrees Centigrade

$\rho$  in metric units of  $\frac{kgs^2}{m^4}$

Salinity 3.5%

°C	$\rho$	°C	$\rho$
0	104.83	16	104.59
1	104.82	17	104.56
2	104.81	18	104.54
3	104.81	19	104.52
4	104.80	20	104.49
5	104.79	21	104.46
6	104.77	22	104.43
7	104.76	23	104.40
8	104.74	24	104.37
9	104.73	25	104.34
10	104.71	26	104.31
11	104.69	27	104.28
12	104.68	28	104.24
13	104.65	29	104.21
14	104.63	30	104.18
15	104.61		


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TABLE 3

**Values of Kinematic Viscosity for Fresh Water**

Temperature in degrees Centigrade

$\nu$  in metric units of  $\frac{m^2}{s} 10^6$

°C	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0.	1.78661	1.18056	1.77450	1.76846	1.76246	1.75648	1.75054	1.74461	1.73871	1.73285
1.	1.72701	1.72121	1.71545	1.70972	1.70403	1.69836	1.69272	68710	1.68151	1.67594
2.	1.67040	1.66489	1.65940	1.65396	1.64855	1.64316	1.63780	1.63247	1.62717	1.62190
3.	1.61665	1.61142	1.60622	1.60105	1.59591	1.59079	1.58570	1.58063	1.57558	1.57057
4.	1.56557	1.56060	1.55566	1.55074	1.54585	1.54098	1.53613	1.53131	1.52651	1.52173
5.	1.51698	1.51225	1.50754	1.50286	1.49820	1.49356	1.48894	1.48435	1.47978	1.47523
6.	1.47070	1.46619	1.46172	1.45727	1.45285	1.44844	1.44405	1.43968	1.43533	1.43099
7.	1.42667	1.42238	1.41810	1.41386	1.40964	1.40543	1.40125	1.39709	1.39294	1.38882
8.	1.38471	1.38063	1.37656	1.37251	1.36848	1.36445	1.36045	1.35646	1.35249	1.34855
9.	1.34463	1.34073	1.33684	1.33298	1.32913	1.32530	1.32149	1.31769	1.31391	1.31015
10.	1.30641	1.30268	1.29897	1.29528	1.29160	1.28794	1.28430	1.28067	1.27706	1.27346
11.	1.26988	1.26612	1.26277	1.25924	1.25573	1.25223	1.24874	1.24527	1.24182	1.23838
12.	1.23495	1.23154	1.22815	1.22478	1.22143	1.21809	1.21477	1.21146	1.20816	1.20487
13.	1.20159	1.19832	1.19508	1.19184	1.18863	1.18543	1.18225	1.7908	1.17592	1.17278
14.	1.16964	1.16651	1.16340	1.16030	1.15721	1.15414	1.15109	1.14806	1.14503	1.14202
15.	1.13902	1.13603	1.13304	1.13007	1.12711	1.12417	1.12124	1.11832	1.11542	1.11254
16.	1.10966	1.10680	1.10395	1.10110	1.09828	1.09546	1.09265	1.08986	1.08708	1.08431
17.	1.08155	1.01880	1.07606	1.07334	1.07062	1.06792	1.06523	1.06254	1.05987	1.05721
18.	1.05456	1.05193	1.04930	1.04668	1.04407	1.04148	1.03889	1.03631	1.03315	1.03119
19.	1.02865	1.02611	1.02359	1.02107	1.01857	1.01607	1.01359	1.01111	1.00865	1.00619
20.	1.00374	1.00131	0.99888	0.99646	0.99405	0.99165	0.98927	0.98690	0.98454	0.98218
21.	0.97984	0.97750	0.97517	0.97285	0.97053	0.96822	0.96592	0.96363	0.96135	0.95908
22.	0.95682	0.95456	0.95231	0.95008	0.94786	0.94565	0.94345	0.94125	0.93906	0.93688
23.	0.93471	0.93255	0.93040	0.92825	0.92611	0.92397	0.92184	0.91971	0.91760	0.915149
24.	0.91340	0.91132	0.90924	0.90718	0.90512	0.90306	0.90102	0.89898	0.89695	0.89493
25.	0.89292	0.89090	0.88889	0.88689	0.88490	0.88291	0.88094	0.87697	0.87702	0.87507
26.	0.87313	0.87119	0.86926	0.86734	0.86543	0.86352	0.86162	0.85973	0.85784	0.85596
27.	0.854091	0.85222	0.85036	0.84851	0.84666	0.84482	0.84298	0.84116	0.83934	0.83752
28.	0.83572	0.83391	0.83212	0.83033	0.82855	0.82677	0.82500	0.82324	0.82148	0.81973
29.	0.81798	0.81625	0.81451	0.81279	0.81106	0.80935	0.80765	0.80596	0.80427	0.80258
30.	0.80091	0.79923	0.79755	0.79588	0.79422	0.79256	0.79090	0.78924	0.78757	0.78592


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TABLE 4

**Values of Kinematic Viscosity for Salt Water**

Temperature in degrees Centigrade

$\nu$  in metric units of  $\frac{m^2}{s} 10^6$

Salinity 3.5%

°C	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0.	1.82844	1.82237	1.81633	1.81055	1.80436	1.79842	1.79251	1.78662	1.78077	1.77494
1.	1.76915	1.76339	1.75767	1.75199	1.74634	1.74072	1.73513	1.72956	1.72403	1.71853
2.	1.71306	1.70761	1.70220	1.69681	1.69145	1.68612	1.68082	1.67554	1.67030	1.66508
3.	1.65988	1.65472	1.64958	1.64446	1.63938	1.53432	1.62928	1.62427	1.61929	1.61433
4.	1.60940	1.60449	1.59961	1.59475	1.58992	1.58511	1.58032	1.57556	1.57082	1.56611
5.	1.56142	1.55676	1.55213	1.54752	1.54294	1.53838	1.53383	1.52930	1.52479	1.52030
6.	1.51584	1.51139	1.50692	1.50259	1.49823	1.49388	1.48956	1.48525	1.48095	1.47667
7.	1.47242	1.46818	1.46397	1.45918	1.45562	1.45147	1.44735	1.44325	1.43916	1.43508
8.	1.43102	1.42698	1.42296	1.41895	1.41498	1.41102	1.40709	1.40317	1.39927	1.39539
9.	1.39152	1.38767	1.38385	1.38003	1.37624	1.37246	1.36870	1.36496	1.36123	1.35752
10.	1.35383	1.35014	1.34647	1.34281	1.33917	1.33555	1.33195	1.32837	1.32481	1.32126
11.	1.31773	1.31421	1.31011	1.30722	1.30375	1.30030	1.29685	1.29343	1.29002	1.28662
12.	1.28324	1.27987	1.27652	1.27319	1.26988	1.26658	1.26360	1.26003	1.25671	1.25352
13.	1.25028	1.24705	1.24384	1.24064	1.23745	1.23428	1.23112	1.22798	1.22484	1.22172
14.	1.21862	1.21552	1.21244	1.20938	1.20632	1.20328	1.20027	1.19726	1.19426	1.19128
15.	1.18431	1.18534	1.18239	1.17944	1.17651	1.17359	1.17068	1.16778	1.16490	1.16202
16.	1.15916	1.15631	1.15348	1.15066	1.14786	1.14506	1.14228	1.13951	1.13674	1.13399
17.	1.13125	1.12852	1.12581	1.12309	1.12038	1.11769	1.11500	1.11232	1.10966	1.10702
18.	1.10438	1.10176	1.09914	1.09654	1.09394	1.09135	1.08876	1.09619	1.08363	1.08107
19.	1.07854	1.07601	1.073b0	1.07099	1.06850	1.06601	1.06353	1.06106	1.05861	1.05616
20.	1.05372	1.05129	1.04886	1.04645	1.04405	1.04165	1.03927	1.03699	1.03452	1.03216
21.	1.02781	1.02747	1.02514	1.02281	1.02050	1.01819	1.01589	1.01360	1.01132	1.00904
22.	1.0067	1.00452	1.00227	1.00003	0.99780	0.99557	0.99336	0.99115	0.98895	0.98676
23.	0.98457	0.98239	0.98023	0.9780b	0.97591	0.97376	0.97163	0.96950	0.96737	0.96526
24.	0.96315	0.96105	0.95896	0.95687	0.95479	0.95272	0.95067	0.94862	0.94658	0.94455
25.	0.94252	0.94049	0.93847	0.93646	0.93445	0.93245	0.93046	0.92847	0.92649	0.92452
26.	0.92255	0.92059	0.91865	0.91671	0.91478	0.91286	0.91094	0.90903	0.90711	0.90521
27.	0.90331	0.90141	0.89953	0.89765	0.89579	0.89393	0.89207	0.89023	0.88838	0.88654
28.	0.88470	0.88287	0.88105	0.87923	0.87742	0.87562	0.87383	0.87205	0.87927	0.86849
29.	0.86671	0.86494	0.86318	0.86142	0.85966	0.85792	0.85619	0.85446	0.85274	0.85102
30.	0.84931	0.84159	0.84588	0.84418	0.84248	0.84079	0.83910	0.83739	0.83570	0.83400