EXPERIMENTAL VALUES OF STARTING-VORTEX LENGTH FOR CIRCULAR CYLINDERS

HONJI, Hiroyuki
Institute for Applied Mechanics, Kyushu University : Lecturer

TANEDA, Sadatoshi
Institute for Applied Mechanics, Kyushu University : Professor

https://doi.org/10.5109/7172203

出版情報：Reports of Research Institute for Applied Mechanics. 19 (64), pp.265-269, 1972. 九州大学応用力学研究所
バージョン：
権利関係：

Reports of Research Institute for Applied Mechanics
Vol. XIX, No. 64, 1972

NOTE

EXPERIMENTAL VALUES OF STARTING-VORTEX LENGTH FOR CIRCULAR CYLINDERS

By Hiroyuki HONJI† and Sadatoshi TANEDA††

Some years ago, an experimental investigation of starting flow past circular cylinders was made by the present authors, and the result obtained was reported in a preceding paper.[1] Although many graphs and photographs were included in that paper, experimental raw values have been omitted totally for want of space. In the course of further study of various types of unsteady flows, however, frequent use has been made of the concrete numerical values for comparison's sake. At present their presention in a tabular form seems to be desirable. This short note is devoted to this end, and should be considered as an addendum to the preceding report.

Following the order of presentation in Ref. 1, the data on the vortices formed behind impulsively started cylinders are presented in the first place, and the data for accelerated ones in the second place. For completeness, notation used in Ref. 1 is extracted here.

U_0: Cylinder speed
a : Cylinder acceleration
d : Cylinder diameter
s : Vortex length measured from rear end of model cylinder
ν : Kinematic viscosity
t : Time elapsed since starting of motion
R : Reynolds number $(=U_0 d/\nu)$
α : Dimensionless acceleration $(=d^3 a/\nu^2)$
τ : Dimensionless time $(=\nu t/d^2)$

† Lecturer, †† Professor, Research Institute for Applied Mechanics, Kyushu University.

Table I Data on twin vortices formed behind impulsively started circular cylinders.

R	t(sec)	τ	U_0t/d	s (cm)	s/d	$(s/d)\ \tau^{-1}$
	4.48	0.0515	1.61	0.320	0.320	6.21
	8.70	0.100	3.12	0.860	0.860	8.60
	13.60	0.156	4.88	1.31	1.31	8.40
	18.92	0.218	6.79	1.49	1.49	6.83
	24.22	0.279	8.69	1.56	1.56	5.59
	29.72	0.342	10.7	1.58	1.58	4.62
	35.12	0.404	12.6	1.60	1.60	3.96
31.2	40.62	0.467	14.6	1.66	1.66	3.55
	46.02	0.529	16.5	1.54	1.54	2.91
	52.24	0.601	18.8	1.56	1.56	2.60
	53.16	0.611	19.1	1.59	1.59	2.60
	64.26	0.739	23.1	1.54	1.54	2.08
	70.22	0.808	25.2	1.58	1.58	1.96
	76.80	0.883	27.6	1.62	1.62	1.83
	83.06	0.955	29.8	1.74	1.74	1.82
	2.96	0.0315	1.26	0.350	0.350	11.1
	6.04	0.0643	2.57	0.930	0.930	14.5
	8.40	0.0895	3.58	1.30	1.30	14.5
	10.78	0.115	4.59	1.52	1.52	13.2
	13.12	0.140	5.59	1.70	1.70	12.1
	15.40	0.164	6.56	1.94	1.94	11.8
	17.84	0.190	7.60	2.15	2.15	11.3
	20.52	0.219	8.74	2.20	2.20	10.0
	23.00	0.245	9.80	2.35	2.35	9.59
	25.44	0.271	10.8	2.40	2.40	8.86
40.0	28.12	0.299	12.0	2.25	2.25	7.53
	30.90	0.329	13.2	2.40	2.40	7.29
	35.10	0.374	15.0	2.72	2.72	7.27
	38.60	0.411	16.4	2.65	2.65	6.45
	42.50	0.453	18.1	2.57	2.57	5.67
	47.10	0.502	20.1	2.60	2.60	5.18
	51.70	0.551	22.0	2.82	2.82	5.12
	57.20	0.606	24.4	2.84	2.84	4.66
	67.90	0.723	28.9	3.10	3.10	4.29
	76.30	0.813	32.5	3.02	3.02	3.71
	86.50	0.921	36.8	2.90	2.90	3.15
	3.00	0.0143	1.03	0.580	0.387	27.1
	5.32	0.0253	1.83	1.22	0.813	32.1
	7.68	0.0365	2.64	1.70	1.13	31.0
	9.96	0.0474	3.42	2.12	1.41	29.7
	12.08	0.0574	4.15	2.48	1.65	28.7
	14.36	0.0683	4.93	2.80	1.87	27.4
	16.96	0.0807	5.82	3.15	2.10	26.0
	19.28	0.0917	6.62	3.40	2.27	24.8
72.2	21.64	0.103	7.43	3.70	2.47	24.0
	24.04	0.114	8.25	3.97	2.65	23.2
	26.44	0.126	9.08	4.25	2.83	2.25
	28.68	0.136	9.85	4.50	3.00	2.21
	31.30	0.149	10.7	4.72	3.15	2.11
	34.50	0.164	11.8	4.86	3.24	1.98
	37.10	0.176	12.7	5.20	3.47	1.67
	39.50	0.188	13.6	5.38	3.59	1.91
	42.20	0.201	14.5	5.00	3.33	1.66
	44.90	0.214	15.4	5.30	3.53	1.65

R	t (s)	τ	$U_0 t/d$	s (cm)	s/d	$(s/d)\tau^{-1}$
100	3.46	0.00934	0.934	0.700	0.350	37.5
	5.32	0.0144	1.44	1.20	0.600	41.7
	7.48	0.0202	2.02	1.65	0.825	40.8
	9.60	0.0259	2.59	2.10	1.05	40.5
	11.72	0.0316	3.16	2.60	1.30	41.1
	13.86	0.0374	3.74	2.95	1.48	39.6
	16.12	0.0435	4.35	3.45	1.73	39.8
	18.48	0.0499	4.99	3.70	1.85	37.1
	20.32	0.0549	5.49	4.00	2.00	36.4
	22.88	0.0618	6.18	4.20	2.10	34.0
	25.08	0.0677	6.77	4.60	2.30	34.0
	27.32	0.0738	7.38	4.90	2.45	33.2
	29.40	0.0794	7.64	5.20	2.60	32.7
	31.78	0.0858	8.58	5.45	2.73	31.8
	33.94	0.0916	9.16	5.90	2.95	32.2
	36.18	0.0977	9.77	6.25	3.13	32.0
	38.05	0.103	10.3	6.60	3.30	32.0
	40.70	0.110	11.0	6.90	3.45	31.4
	42.80	0.116	11.6	7.15	3.58	30.9
	45.10	0.122	12.2	7.35	3.68	30.2
	47.20	0.127	12.7	7.55	3.78	29.8
	49.50	0.134	13.4	7.80	3.90	29.1
	51.80	0.140	14.0	8.05	4.03	28.8
	54.20	0.146	14.6	8.35	4.18	28.6
	56.80	0.153	15.3	8.65	4.32	28.3
	59.20	0.160	16.0	8.90	4.45	27.8
200	3.28	0.00589	1.18	1.05	0.417	70.8
	5.24	0.00940	1.88	1.90	0.755	80.3
	7.20	0.0129	2.59	2.50	0.994	77.1
	9.12	0.0164	3.27	3.10	1.23	75.0
	10.96	0.0197	3.94	3.75	1.49	75.6
	12.96	0.0233	4.65	4.35	1.73	74.2
	15.04	0.0270	5.40	4.90	1.95	72.2
	16.84	0.0302	6.05	5.45	2.17	71.9
	18.68	0.0335	6.71	6.00	2.39	71.3
	20.68	0.0371	7.43	6.60	2.62	70.6
	22.60	0.0406	8.11	7.20	2.86	70.4
	24.44	0.0439	8.78	7.80	3.10	70.6
	26.44	0.0474	9.49	8.55	3.40	71.7
	28.44	0.0510	10.2	9.35	3.72	72.9
303	2.68	0.00466	1.41	1.55	0.616	132
	4.96	0.00863	2.61	2.40	0.954	111
	6.76	0.0118	3.56	3.15	1.25	106
	8.68	0.0151	4.57	3.80	1.51	100
	10.52	0.0183	5.54	4.60	1.83	100
	12.36	0.0215	6.51	5.25	2.09	97.2
	14.32	0.0249	7.54	6.30	2.50	100
	16.24	0.0282	8.56	7.35	2.92	904
	18.16	0.0316	9.57	8.25	3.28	104
550	2.00	0.00165	0.909	0.900	0.264	160
	3.76	0.00310	1.71	2.00	0.587	189
	5.48	0.00452	2.49	3.00	0.880	195
	7.32	0.00604	3.33	3.70	1.09	181
	9.12	0.00753	4.15	4.70	1.38	183
	12.75	0.0105	5.80	7.00	2.05	195

R	t(sec)	τ	$U_0\, t/d$	s (cm)	s/d	$(s/d)\,\tau^{-1}$
1000	3. 20	0. 00105	1. 05	1. 50	0. 273	260
	5. 72	0. 00187	1. 87	3. 40	0. 618	331
	7. 56	0. 00247	2. 47	4. 60	0. 836	339
	9. 56	0. 00313	3. 13	6. 10	1. 11	355
	11. 75	0. 00385	3. 85	7. 70	1. 40	364
1500	2. 56	0. 000812	1. 22	1. 70	0. 309	381
	4. 20	0. 00133	2. 00	3. 60	0. 655	493
	5. 88	0. 00187	2. 80	5. 50	1. 00	535
	7. 43	0. 00236	3. 54	7. 50	1. 36	576
	9. 04	0. 00287	4. 31	9. 50	1. 73	603
1700	3. 48	0. 00113	1. 92	3. 40	0. 618	547
	5. 44	0. 00176	3. 00	5. 40	0. 982	558
	7. 36	0. 00238	4. 05	9. 80	1. 78	748

Table II Data on twin vortices formed behind uniformly accelerated circular cylinders.

α	t(sec)	τ	at^2/d	s (cm)	s/d	$(s/d)\tau^{-2}$
195	6. 40	0. 0763	1. 23	0. 12	0. 12	19. 0
	12. 24	0. 152	4. 49	0. 66	0. 66	28. 6
	17. 04	0. 211	8. 71	1. 0	1. 0	22. 5
	22. 24	0. 276	14. 8	1. 42	1. 42	18. 6
	28. 16	0. 350	23. 8	1. 94	1. 94	15. 8
	32. 24	0. 400	31. 2	2. 24	2. 24	14. 0
	36. 60	0. 454	40. 2	2. 67	2. 67	13. 0
	40. 30	0. 500	48. 7	2. 90	2. 90	11. 6
	43. 80	0. 543	57. 6	3. 27	3. 27	11. 1
	48. 80	0. 605	71. 4	3. 57	3. 57	97. 5
	53. 70	0. 666	86. 5	3. 70	3. 70	83. 4
501	4. 20	0. 0521	1. 36	0. 20	0. 20	73. 6
	7. 56	0. 0937	4. 40	0. 55	0. 550	63. 2
	10. 96	0. 136	9. 25	1. 37	1. 37	74. 1
	12. 84	0. 159	12. 7	1. 53	1. 53	60. 5
	14. 84	0. 184	17. 0	2. 10	2. 10	62. 0
	17. 60	0. 218	23. 9	2. 50	2. 50	52. 7
	19. 64	0. 244	29. 7	2. 94	2. 94	49. 8
	21. 54	0. 267	35. 7	3. 09	3. 06	42. 9
	23. 56	0. 292	42. 7	3. 40	3. 40	39. 9
	25. 44	0. 315	49. 8	3. 68	3. 68	37. 1
	27. 25	0. 338	57. 2	4. 13	4. 13	36. 2
	28. 98	0. 359	64. 7	4. 66	4. 66	36. 1
2370	3. 64	0. 0193	0. 883	0. 20	0. 133	357
	5. 84	0. 0309	2. 27	0. 50	0. 333	349
	7. 76	0. 0410	4. 01	0. 90	0. 600	357
	9. 76	0. 0516	6. 35	1. 25	0. 833	313
	11. 64	0. 0615	9. 03	1. 90	1. 27	336
	13. 66	0. 0722	12. 4	2. 50	1. 67	320
	15. 52	0. 0821	16. 1	3. 00	2. 00	297
	17. 44	0. 0922	20. 3	3. 55	2. 37	279
	19. 32	0. 102	24. 9	4. 10	2. 73	262
	21. 08	0. 112	29. 6	4. 55	3. 03	242

α	t(sec)	τ	at^2/d	s (cm)	s/d	$(s/d)\tau^{-2}$
	22.92	0.121	35.0	5.05	3.37	230
	24.60	0.130	40.4	5.50	3.67	217
	2.32	0.0124	1.79	0.30	0.200	1300
	3.80	0.0202	4.81	1.10	0.733	1800
	5.12	0.0273	8.74	1.95	1.30	1740
11700	6.48	0.0346	14.0	2.70	1.80	1500
	7.84	0.0418	20.5	3.50	2.33	1330
	9.08	0.0484	27.5	4.30	2.87	1230
	10.38	0.0553	35.9	5.00	3.33	1090
	4.52	0.0139	3.78	1.09	0.545	2820
	6.36	0.0196	7.48	2.30	1.15	2990
19600	8.08	0.0248	12.1	3.34	1.67	2710
	9.80	0.0301	17.8	4.36	2.18	2410
	11.44	0.0352	24.2	5.35	2.68	2160
	10.95	0.00552	1.44	0.90	0.18	5920
	13.72	0.00691	2.26	1.70	0.340	7100
	16.40	0.00827	3.23	2.45	0.490	7160
	19.20	0.00968	4.42	3.55	0.710	7330
46500	22.70	0.0114	6.18	4.80	0.960	7400
	25.50	0.0129	7.80	6.00	1.20	7200
	28.40	0.0143	9.68	7.30	1.46	7130
	31.30	0.0158	11.8	8.75	1.75	7000
	34.50	0.0174	14.3	11.0	2.20	7280
	4.80	0.00238	1.38	0.55	0.110	19400
	6.80	0.00337	2.77	1.90	0.380	33500
	8.88	0.00440	4.73	3.40	0.680	34800
244000	10.84	0.00538	7.05	4.90	0.980	33900
	12.80	0.00635	9.83	6.90	1.38	34200
	14.72	0.00730	13.0	9.75	1.95	36600

Reference

1) Honji, H. and Taneda, S.,
Unsteady Flow past a Circular Cylinder, J. Phys. Soc. Japan, Vol. 27, No. 6, 1969, pp. 1668-1677.

(Received September 23, 1971)