2024年12月北京测试中心扭矩仪测试数据分析

2024/12/12

说明：原计划是对A-Line 生产的M泵的转速提高到2倍（即变频器的供电频率从50提高到100hz），观察M泵的性能变化。但实际测试过程发现变频器的功率不够支持100hz的测试，所以降低到90hz进行测试。

Analysis of the torque instrument test data of Beijing Test Center in December 2024

12/12/2024

Note: The original plan was to increase the speed of the M pump produced by A-Line to 2 times (i.e., the power supply frequency of the frequency transformer was increased from 50 to 100hz) to observe the performance changes of the M pump. However, the actual test process found that the power of the frequency transformer was not enough to support the 100hz test, so it was reduced to 90hz for testing.

水泵性能试验记录

试验编号：20241212-50B-2

水泵型号：M-50　　产品编号：20231213002

序号	试验数据							
	流量		出口压力	进口压力	扬程	动扬程	转速	扭矩
	(L/s)	(m^3/h)	(MPa)	(MPa)	(m)	(m)	(r/min)	(N.m)
1	0.00	0.000	0.2717	0.0140	26.28	0.00	2995.6	3.7500
2	2.79	10.039	0.2707	0.0059	27.00	0.00	2993.3	5.5100
3	4.20	15.108	0.2674	0.0052	26.73	0.00	2993.0	6.5900
4	5.62	20.233	0.2594	0.0043	26.01	0.00	2992.5	7.4600
5	6.96	25.056	0.2473	0.0032	24.90	0.00	2991.7	8.4100
6	8.37	30.146	0.2339	0.0017	23.68	0.00	2990.8	9.1300
7	9.77	35.158	0.2177	0.0000	22.20	0.00	2990.1	10.0800
8	11.12	40.037	0.1974	-0.0020	20.34	0.00	2989.3	10.7900
9	12.50	45.014	0.1765	-0.0043	18.44	0.00	2988.8	11.5000
10	13.93	50.140	0.1550	-0.0069	16.50	0.00	2988.2	11.8900
11	14.83	53.404	0.1388	-0.0087	15.03	0.00	2988.0	12.3600
12	/	/	/	/	/	/	/	/
13	/	/	/	/	/	/	/	/
14	/	/	/	/	/	/	/	/
15	/	/	/	/	/	/	/	/
16	/	/	/	/	/	/	/	/

序号	计算数据				换算至额定转速n_{sp}= 2950 r/min			
	流量	总扬程	水功率	轴功率	流量	扬程	轴功率	泵效率
	(m^3/h)	(m)	(kW)	(kW)	(m^3/h)	(m)	(kW)	(%)
1	0.000	26.28	0.000	1.176	0.000	25.48	1.123	0.00
2	10.039	27.00	0.738	1.727	9.894	26.23	1.653	42.75
3	15.108	26.73	1.100	2.065	14.891	25.97	1.978	53.25
4	20.233	26.01	1.433	2.338	19.946	25.28	2.239	61.31
5	25.056	24.90	1.699	2.635	24.706	24.21	2.526	64.49
6	30.146	23.68	1.944	2.859	29.735	23.03	2.744	67.98
7	35.158	22.20	2.126	3.156	34.687	21.61	3.031	67.36
8	40.037	20.34	2.218	3.377	39.511	19.81	3.246	65.66
9	45.014	18.44	2.260	3.599	44.430	17.96	3.461	62.80
10	50.140	16.50	2.253	3.720	49.499	16.08	3.580	60.57
11	53.404	15.03	2.187	3.867	52.725	14.65	3.722	56.54
12	/	/	/	/	/	/	/	/
13	/	/	/	/	/	/	/	/
14	/	/	/	/	/	/	/	/
15	/	/	/	/	/	/	/	/
16	/	/	/	/	/	/	/	/

流量计系数：19.583 L/s.V　　进、出口压力表位高差：0 m

出口取压处管路直径：0.08 m　　进口取压处管路直径：0.08 m

试验人员：　　日期：2024/12/12

Speed rpm

torque

flow/head/water power/shaft power

pump efficiency

表1　M泵50hz　　Table 1　M pump 50hz

水泵性能试验记录

试验编号：20241212-90B-2

水泵型号：M-90　　产品编号：20231213002

序号	试验数据							
	流量		出口压力	进口压力	扬程	动扬程	转速	扭矩
	(L/s)	(m^3/h)	(MPa)	(MPa)	(m)	(m)	(r/min)	(N.m)
1	0.14	0.486	0.8490	0.0280	83.72	0.00	5340.7	13.4700
2	2.85	10.258	0.8477	0.0130	85.11	0.00	5330.6	15.5800
3	4.18	15.031	0.8345	0.0081	84.27	0.00	5282.6	17.8500
4	5.60	20.149	0.8317	0.0045	84.34	0.00	5298.0	18.0300
5	7.06	25.422	0.8326	0.0033	84.57	0.00	5327.0	19.4100
6	8.38	30.153	0.8166	0.0018	83.08	0.00	5311.2	20.3600
7	9.77	35.158	0.7993	0.0000	81.50	0.00	5283.8	21.2800
8	11.17	40.213	0.7844	-0.0019	80.18	0.00	5309.7	21.2300
9	12.53	45.106	0.7582	-0.0042	77.75	0.00	5301.1	22.1600
10	13.95	50.231	0.7322	-0.0068	75.35	0.00	5293.6	23.5200
11	15.35	55.244	0.7072	-0.0097	73.11	0.00	5283.0	25.3900
12	16.72	60.207	0.6763	-0.0129	70.29	0.00	5273.8	27.4400
13	18.09	65.128	0.6487	-0.0164	67.82	0.00	5253.7	30.5800
14	19.50	70.204	0.6180	-0.0200	65.06	0.00	5240.5	32.7300
15	20.89	75.188	0.5829	-0.0242	61.91	0.00	5227.7	34.0100
16	/	/	/	/	/	/	/	/

序号	计算数据				换算至额定转速n_{sp}= 5310 r/min			
	流量	总扬程	水功率	轴功率	流量	扬程	轴功率	泵效率
	(m^3/h)	(m)	(kW)	(kW)	(m^3/h)	(m)	(kW)	(%)
1	0.486	83.72	0.111	7.533	0.484	82.76	7.404	1.47
2	10.258	85.11	2.378	8.696	10.218	84.45	8.596	27.34
3	15.031	84.27	3.449	9.874	15.109	85.14	10.028	34.93
4	20.149	84.34	4.628	10.002	20.195	84.73	10.071	46.27
5	25.422	84.57	5.855	10.827	25.341	84.03	10.724	54.08
6	30.153	83.08	6.822	11.323	30.146	83.05	11.315	60.25
7	35.158	81.50	7.804	11.774	35.333	82.31	11.950	66.28
8	40.213	80.18	8.781	11.804	40.215	80.19	11.806	74.39
9	45.106	77.75	9.550	12.301	45.182	78.01	12.363	77.64
10	50.231	75.35	10.308	13.037	50.387	75.82	13.159	79.07
11	55.244	73.11	10.999	14.046	55.526	73.86	14.262	78.31
12	60.207	70.29	11.524	15.153	60.620	71.25	15.467	76.05
13	65.128	67.82	12.029	16.823	65.826	69.29	17.369	71.51
14	70.204	65.06	12.439	17.960	71.135	66.80	18.684	69.26
15	75.188	61.91	12.677	18.617	76.372	63.88	19.510	68.09
16	/	/	/	/	/	/	/	/

流量计系数：19.583 L/s.V　　进、出口压力表位高差：0 m

出口取压处管路直径：0.08 m　　进口取压处管路直径：0.08 m

表2　M泵90hz

Table 2　M pump 90hz

根据众所周知的普通离心泵阿菲尼提定律（Affinity rules）：转速提高到2倍，流量增高到2倍，扬程增高4倍，功率增高8倍。

但是，在表1和表2的最高效率点数据中，转速从2990.8到5293.6rpm，提高1.77倍，流量从30.146到50.231m^3/h 增高1.67倍（按普通离心泵阿菲尼提定律应该是1.77倍），扬程从23.68 到75.35m 增高3.18倍（按普通离心泵阿菲尼提定律应该是3.13倍），轴功率从2.859 到13.037kw，只增高4.56倍（低于按普通离心泵阿菲尼提定律

的5.55倍），水功率从1.944 到10.308kw，增高了5.30倍（高于轴功率的提高4.56倍），导致水泵效率从67.98提高到79.07%，即效率提高1.16倍。这些数据，理论上说，突破了众所周知的普通离心泵阿菲尼提定律，技术上说，在不改变水泵尺寸的前提下，可以用提高转速的方法，提高扬程、流量和效率，即形成这种泵的特点：“节能高扬程体积小”。这个特点对许多使用现场空间受严格限制的应用领域有重要意义，如车、船、航空航天飞行器、井下和消防车现场等等。

According to the well-known Affinity rules for ordinary centrifugal pumps: if the speed is increased by 2 times, the flow rate will increase by 2 times, the head will increase by 4 times, and the power will increase by 8 times. However, in the highest efficiency point data in Table 1 and Table 2, the speed increased from 2990.8 to 5293.6rpm, an increase of 1.77 times, the flow rate increased from 30.146 to 50.231m3/h, an increase of 1.67 times (according to the Affiniti law of ordinary centrifugal pumps, it should be 1.77 times), the head increased from 23.68 to 75.35m, an increase of 3.18 times (according to the Affiniti law of ordinary centrifugal pumps, it should be 3.13 times), the shaft power increased from 2.859 to 13.037kw, only an increase of 4.56 times (lower than the 5.55 times according to the Affiniti law of ordinary centrifugal pumps), the water power increased from 1.944 to 10.308kw, an increase of 5.30 times (higher than the 4.56 times increase in shaft power), resulting in the water pump efficiency increasing from 67.98 to 79.07%, that is, the efficiency increased by 1.16 times. In theory, these data break through the well-known Affinity Law of ordinary centrifugal pumps. Technically, without changing the size of the pump, the head, flow rate and efficiency can be increased by increasing the speed, that is, the characteristics of this pump are: "energy saving, high head and small size". This feature is of great significance to many application fields where the space on site is strictly limited, such as vehicles, ships, aerospace vehicles, underground and fire truck sites, etc.

最为重要的是，根据单级离心泵效率GB 13007-91中国国家标准（图1. 这是一个一般中国水泵公司的产品很难达到的高标准），当流量50吨/时，效率要求75%。但我们的90hz专利技术高速泵，可以达到效率80%！！！这预示我们的专利技术高速泵可能是未来水泵市场的新方向。

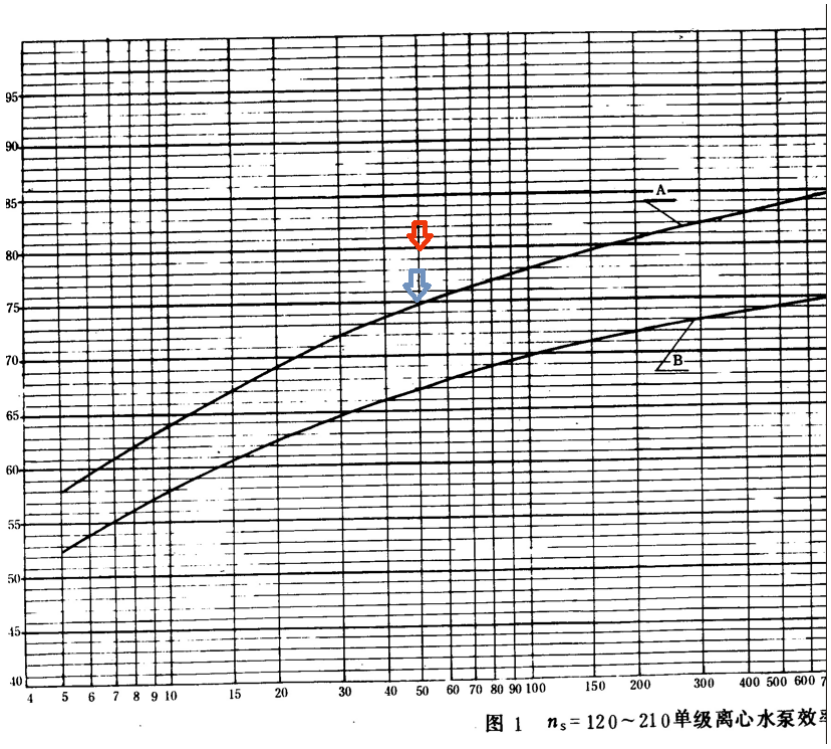

图1　　单级离心泵效率GB 13007-91中国国家标准

Figure 1　　Chinese national standard GB 13007-91

Most importantly, according to the Chinese national standard GB 13007-91 for single-stage centrifugal pump efficiency (Figure 1. This is a high standard that hard to achieve by products of general Chinese water pump companies), when the flow rate is 50 tons/hour, the efficiency requirement is 75%. However, our 90hz patented high-speed pump can achieve an efficiency of 80%!!! This indicates that our patented high-speed pump may be a new direction for the future water pump market.