



ZUIKERBOSCH PUMPING STATION

ENGINE ROOM 4

PUMP TEST REPORT FOR PUMP SET 23

DOCUMENT CODE

C 00548

WKS CODE

ZB # 4 0UGH



20 February 2015

PERFORMANCE TEST CONDUCTED ON PUMP SET 23 IN ENGINE ROOM 4A AT ZUIKERBOCSH PUMPING STATION

THE FOLLOWING POINTS WERE DETERMINED FOR THE PUMP-SET:

1. Generated head at duty flow rate.
2. Pump power demand at duty flow rate.
3. Corresponding overall efficiency.

METHOD OF TESTING

Power Input Measurement

Electrical power demand of the pump-set was based on the two wattmeter method, using an electronic sub-standard energy meter.

Measurement of Flow Rate

The rate of flow was determined by measuring the differential pressure generated by a Venturi installed in the delivery pipeline of the pump-set using a calibrated differential pressure transmitter.

Head Measurement

The generated head of the pump-set was obtained from test pressure transmitters which were calibrated by an NLA traceable laboratory. Accuracy class of the test pressure transmitters is 0.25%.

RESULTS

The results of the test are shown on the attached copies of the following:

1. Pump test data sheets indicating all flow, head, power and efficiency characteristics of the pump-set as well as calculations for power demand at duty point
2. Characteristic curves for the pump-set, namely:
 - a) Quantity - Head
 - b) Quantity - Power
 - c) Quantity -Efficiency

SUMMARY OF PUMP-SET PERFORMANCE

DATE OF TEST:	04 February 2015
PUMPING STATION:	Zuikerbosch
PUMP-SET:	23
PUMP-SET DUTY:	200 Ml/d @ 185 m
OPERATING HOURS SINCE PREVIOUS TEST	7 896
TOTAL OPERATING HOURS	89 167

COMMENTS

Routine test.

FLOW RATE AT DUTY GENERATED HEAD

After Overhaul (Ml/d)	TEST	DIFFERENCE	DEVIATION %
217.6	203.14	-14.46	-6.65

GENERATED HEAD AT DUTY FLOW

After Overhaul (m)	TEST	DIFFERENCE	DEVIATION %
198.97	187.66	-11.31	-5.68

PUMP-SET EFFICIENCY COMPARISON

After Overhaul (%)	TEST	DIFFERENCE	DEVIATION %
83.15	83.10	-0.05	-0.06

POWER DEMAND AT DUTY POINT

After Overhaul (kW)	TEST	DIFFERENCE	DEVIATION %
5030.64	5033.00	2.36	0.05

ECONOMIC EVALUATION TO OVERHAUL PUMP-SET

Date of last overhaul	July 2000
Operating hours since acceptance or overhaul	36 055
Pump-set utilization	33.91%
Interest rate	9.00%
Energy charge (R/kWh)	R 0.70
Monthly saving if pump-set efficiency is restored to original efficiency	R 527.56
NPV of saving in electrical cost if pump-set is restored to original efficiency	R 11,455.10 *

* If the cost to overhaul the pump-set exceeds this amount, the overhaul of the pump-set is not viable.

CONCLUSION

The negative deviation in flow rate at the duty head is relatively unchanged when compared to the previous test result.
Pump-set 23 to remain in service until a definite negative deviation in how rate is observed.

RECOMMENDATION

Pump-set 23 to be tested after a further 8000 operating hours.

Q van der Berg
SENIOR MECHANICAL ENGINEERING ASSISTANT

P Lephuthing
MECHANICAL ENGINEERING ASSISTANT

R A N D W A T E R

PUMP TEST REPORT

Station:	Zuikerbosch
Engineroom:	4A
Pumps tested:	Pump-set 23
Date of test:	4 February 2015
Observer:	P Lephuthing

DETAILS ARE AS FOLLOWS :-

Contract Number		1387
Pump Manufacturer		MATHER & PLATT
Type of pump (Stage 1)		SDS DV 800/1000
Serial Number (Stage 1)		Not available
Motor Manufacturer (Stage 1)		ASEA
Serial Number (Stage 1)		7250-289
Rated Voltage (Stage 1 and 2)	(kV)	11000
Rated Power	(kW)	1705
Rated Amps	(A)	109
Type of pump (Stage 2)		SDS DV 700/800
Serial Number (Stage 2)		Not available
Motor Manufacturer (Stage 2)		BBC
Serial Number (Stage 2)		ZSM-0139
Rated Power	(kW)	3850
Rated Amps	(A)	235
Duty Flow Rate	(Ml/d)	200.00
Flow Meter Constant		13.7500
Duty Generated Head (Set)	(m)	185.00
Guaranteed Demand (set)	(kW)	4764.68
Guaranteed Efficiency	(%)	87.87
Duty Speed 1st Stage	(r.p.m.)	692.00
Duty Speed 2nd Stage	(r.p.m.)	1492.00
PT nom. ratio		11 000/110
CT ratio 1 st stage		120/1
CT ratio 2 nd stage		250/1
Suction Dia.	(mm)	1000.00
Delivery 1st Stage Dia.	(mm)	800.00
Delivery 2nd Stage Dia.	(mm)	900.00
Total Operating Hours		89 167
Operating Hours Since Overhaul		36 055
Return to Service After Last Overhaul		July 2000
Operating Hours Since Previous Test		7 896
Date of Previous Performance Test		February 2012
Density	(kg/m ³)	997.296
Gravity	(m/sec ²)	9.785
Pump-set Utilization	(%)	33.91

ZUIKERBOSCH PUMP SET 23
SITE READINGS ON SUBSTANDARD INSTRUMENTS :-

Ex Overhaul April 2003					Routine Test June 2007					Routine Test August 2009					Routine Test February 2012						Routine Test February 2015			
	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 1	TEST 2	TEST 3	TEST 4	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 6	TEST 1	TEST 2	TEST 3	TEST 4
Delivery valve position	1.00					1.00					1.00				1.00						1.00			
Voltage (kV)	11.40	11.50	11.40	11.40	11.50	11.60	11.60	11.60	11.60	11.50	11.60	11.60	11.60	11.60	11.10	11.00	11.00	11.00	11.00	11.10	11.60	11.60	11.60	11.60
Frequency (Hz)	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	49.90	50.00	50.00	50.00	50.20	50.20	50.20	50.20
Ammeter Readings 1st Stage (A)	112.00	109.50	109.00	107.00	106.50	84.60	84.10	83.70	82.90	82.80	84.70	84.60	83.80	82.80	89.10	88.50	86.50	86.70	86.20	85.80	84.10	83.80	82.80	81.00
Ammeter Readings 2nd Stage (A)	226.50	225.50	224.00	222.00	220.00	219.00	217.00	216.00	215.00	213.00	217.00	218.00	217.00	215.00	216.00	215.00	212.00	211.00	208.00	209.00	214.00	214.00	213.00	210.00
Energy Meter Stage 1 (kWh)	304.51	301.20	298.09	293.84	144.71	281.35	279.74	277.08	273.79	274.42	281.51	279.52	277.04	273.18	280.86	277.57	273.76	273.51	273.10	271.94	278.28	277.72	275.30	272.10
Energy Meter Stage 2 (kWh)	618.64	615.81	611.31	606.87	301.28	592.44	590.74	588.42	584.01	577.71	584.29	591.43	589.48	583.96	578.67	574.49	569.59	566.31	563.09	556.32	577.14	577.51	574.59	568.69
Time (sec.)	600.00	600.00	600.00	600.00	300.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00
Manometer Diff Head (M/d)	284.560	253.333	232.720	208.110	185.105	248.872	231.781	214.349	199.804	172.488	245.417	232.725	213.236	192.405	238.183	223.134	211.498	192.986	185.017	171.043	243.510	227.843	213.016	191.396
Delivery Pressure 2nd Stage (kPa)	1706.17	1840.20	1916.82	2004.29	2061.61	1782.49	1852.72	1919.26	1966.57	2041.47	1761.55	1812.44	1890.68	1964.46	1791.16	1839.89	1872.59	1948.63	1952.03	2013.76	1751.60	1825.33	1878.63	1960.96
Delivery Pressure 1st Stage (kPa)	588.30	628.17	650.51	676.36	678.92	612.20	632.08	650.33	663.01	681.98	593.37	608.73	631.71	654.45	610.33	624.67	633.89	654.12	658.62	669.69	603.91	624.70	640.09	665.64
Suction Pressure (kPa)	46.63	47.69	48.35	49.28	50.25	58.14	58.21	58.15	56.90	57.12	50.42	50.78	51.71	52.65	47.40	49.32	49.87	50.17	50.27	50.19	54.95	56.09	56.51	57.59
Speed 1st Stage (r.p.m.)	744.50	743.00	743.00	743.00	743.00	744.00	745.00	744.00	744.00	744.00	744.00	744.00	744.00	744.00	744.00	744.00	740.00	742.00	743.00	744.00	742.00	743.00	745.00	743.00
Speed 2nd Stage (r.p.m.)	1498.00	1495.00	1496.00	1495.00	1496.00	1497.00	1496.00	1497.00	1495.00	1497.00	1496.00	1497.00	1496.00	1495.00	1498.00	1498.00	1491.00	1493.00	1496.00	1498.00	1490.00	1494.00	1493.00	1496.00

CALCULATED RESULTS 1st & 2nd STAGE:

	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 1	TEST 2	TEST 3	TEST 4	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 6	TEST 1	TEST 2	TEST 3	TEST 4
Motor Current 1st Stage (A)	112.00	109.50	109.00	107.00	106.50	84.60	84.10	83.70	82.90	82.80	84.70	84.60	83.80	82.80	89.10	88.50	86.50	86.70	86.20	85.80	84.10	83.80	82.80	81.00
Motor Current 2nd Stage (A)	226.50	225.50	224.00	222.00	220.00	219.00	217.00	216.00	215.00	213.00	217.00	218.00	217.00	215.00	216.00	215.00	212.00	211.00	208.00	209.00	214.00	214.00	213.00	210.00
Stage kW 1st stage (kW)	1827.06	1807.20	1788.54	1763.04	1736.52	1688.10	1678.44	1662.48	1642.74	1646.52	1689.06	1677.12	1662.24	1639.08	1685.16	1665.42	1642.56	1641.06	1638.60	1631.64	1669.68	1666.32	1651.80	1632.60
Stage kW 2nd stage (kW)	3711.84	3694.86	3667.86	3641.22	3615.48	3554.64	3544.44	3530.52	3504.06	3466.26	3565.74	3548.58	3536.88	3503.76	3472.02	3446.94	3417.54	3397.86	3378.54	3337.92	3462.84	3465.06	3447.54	3412.14
Set kW (kW)	5538.90	5502.06	5456.40	5404.26	5352.00	5242.74	5222.88	5193.00	5146.80	5112.78	5254.80	5225.70	5199.12	5142.84	5157.18	5112.36	5060.10	5038.92	5017.14	4969.56	5132.52	5131.38	5099.34	5044.74
Flow (M/d)	231.947	218.851	209.758	198.358	187.073	216.916	209.335	201.309	194.359	180.585	215.405	209.761	200.786	190.726	212.206	205.393	199.966	191.014	187.029	179.827	214.566	207.549	200.682	190.226
Velocity Head 1st Stage (m)	0.861	0.767	0.704	0.630	0.560	0.753	0.702	0.649	0.605	0.522	0.743	0.704	0.645	0.582	0.721	0.675	0.640	0.584	0.560	0.518	0.737	0.690	0.645	0.579
Generated Head 1st Stage (m)	56.319	60.197	62.355	64.831	64.924	57.478	59.454	61.277	62.659	64.497	56.331	57.828	60.027	62.195	58.355	59.581	60.432	62.417	62.844	63.943	56.840	58.904	60.392	62.832
Velocity Head 2nd Stage (m)	-0.548	-0.488	-0.448	-0.401	-0.357	-0.479	-0.446	-0.413	-0.385	-0.332	-0.473	-0.448	-0.411	-0.371	-0.459	-0.430	-0.407	-0.372	-0.356	-0.329	-0.469	-0.439	-0.410	-0.369
Generated Head 2nd Stage (m)	113.900	123.601	129.198	135.554	141.205	119.336	124.525	129.502	133.075	138.854	119.127	122.789	128.483	133.750	120.436	123.985	126.412	132.162	132.064	137.278	117.033	122.483	126.393	132.247
Total Generated Head (m)	170.218	183.797	191.552	200.385	206.129	176.814	183.979	190.779	195.734	203.350	175.458	180.617	188.511	195.946	178.791	183.566	186.845	194.578	194.908	201.221	173.973	181.387	186.785	195.079
Water kW 1st Stage (kW)	1476.75	1489.32	1478.61	1453.78	1373.04	1409.48	1406.99	1394.53	1376.75	1316.70	1371.74	1371.28	1362.53	1341.01	1399.92	1383.44	1366.13	1347.82	1328.73	1299.92	1381.17	1382.08	1370.11	1351.19
Water kW 2nd Stage (kW)	2986.61	3057.99	3063.66	3039.68	2986.26	2926.38	2946.89	2947.17	2923.92	2834.69	2900.89	2911.72	2916.40	2883.85	2889.22	2878.87	2857.67	2853.90	2792.28	2790.76	2838.81	2873.83	2867.46	2843.95
Water kW (kW)	4463.37	4547.31	4542.27	4493.46	4359.30	4335.86	4353.88	4341.70	4300.68	4151.39	4272.63	4283.01	4278.93	4224.86	4289.14	4262.31	4223.79	4201.71	4121.01	4090.68	4219.98	4255.91	4237.57	4195.14
Efficiency 1st Stage (%)	80.83	82.41	82.67	82.46	79.07	83.49	83.83	83.88	83.81	79.97	81.21	81.76	81.97	81.82	83.07	83.07	83.17	82.13	81.09	79.67	82.72	82.94	82.95	82.76
Efficiency 2nd Stage (%)	80.46	82.76	83.53	83.48	82.60	82.33	83.14	83.48	83.44	81.78	81.35	82.05	82.46	82.31	83.21	83.52	83.62	83.99	82.65	83.61	81.98	82.94	83.17	83.35
Overall Efficiency (%)	80.58	82.65	83.25	83.15	81.45	82.70	83.36	83.61	83.56	81.20	81.31	81.96	82.30	82.15	83.17	83.37	83.47	83.39	82.14	82.31	82.22	82.94	83.10	83.16

SUMMARISED TEST RESULTS FOR PUMP SET :-

Set kW (kW)	5538.90	5502.06	5456.40	5404.26	5352.00	5242.74	5222.88	5193.00	5146.80	5112.78	5254.80	5225.70	5199.12	5142.84	5157.18	5112.36	5060.10	5038.92	5017.14	4969.56	5132.52	5131.38	5099.34	5044.74
Water kW (kW)	4463.37	4547.31	4542.27	4493.46	4359.30	4335.86	4353.88	4341.70	4300.68	4151.39	4272.63	4283.01	4278.93	4224.86	4289.14	4262.31	4223.79	4201.71	4121.01	4090.68	4219.98	4255.91	4237.57	4195.14
Total Generated Head (m)	170.22	183.80	191.55	200.39	206.13	176.81	183.98	190.78	195.73	203.35	175.46	180.62	188.51	195.95	178.79	183.57	186.84	194.58	194.91	201.22	173.97	181.39	186.78	195.08
Flow (M/d)	231.95	218.85	209.76	198.36	187.07	216.92	209.33	201.31	194.36	180.59	215.40	209.76	200.79	190.73	212.21	205.39	199.97	191.01	187.03	179.83	214.57	207.55	200.68	190.23
Set Efficiency (%)	80.58	82.65	83.25	83.15	81.45	82.70	83.36	83.61	83.56	81.20	81.31	81.96	82.30	82.15	83.17	83.37	83.47	83.39	82.14	82.31	82.22	82.94	83.10	83.16

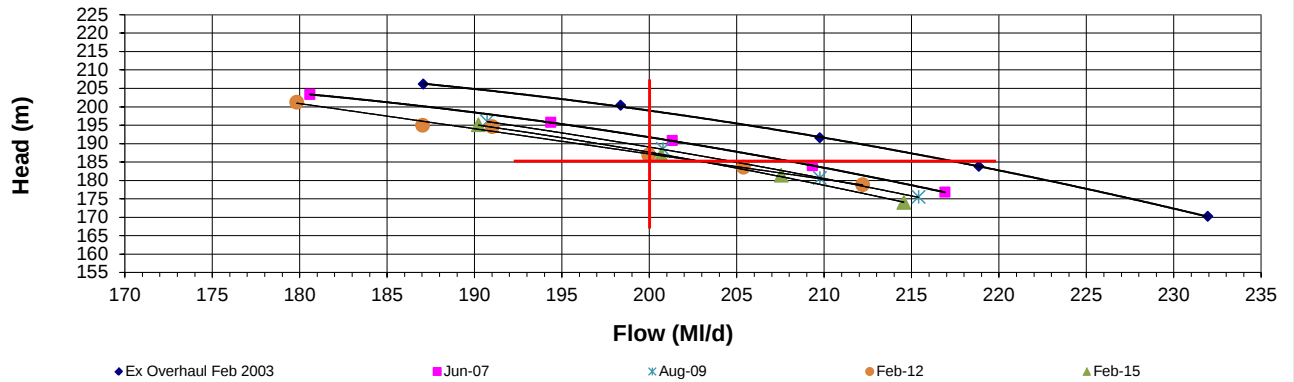
CALCULATED POWER AT DUTY POINT:-

Calculations are based on test with the flow rate nearest to duty point

Flow rate used:			198.36	M/d		201.31	M/d		200.79	M/d		199.97	M/d		200.68	M/d
Efficiency at this point			83.15	%		83.61	%		82.30	%		83.47	%		83.10	%
Power demand at duty point			5030.64	kW		5002.96	kW		5082.33	kW		5011.00	kW		5033.44	kW
Percentage of guaranteed demand			105.58	%		105.00	%		106.67	%		105.17	%		105.64	%

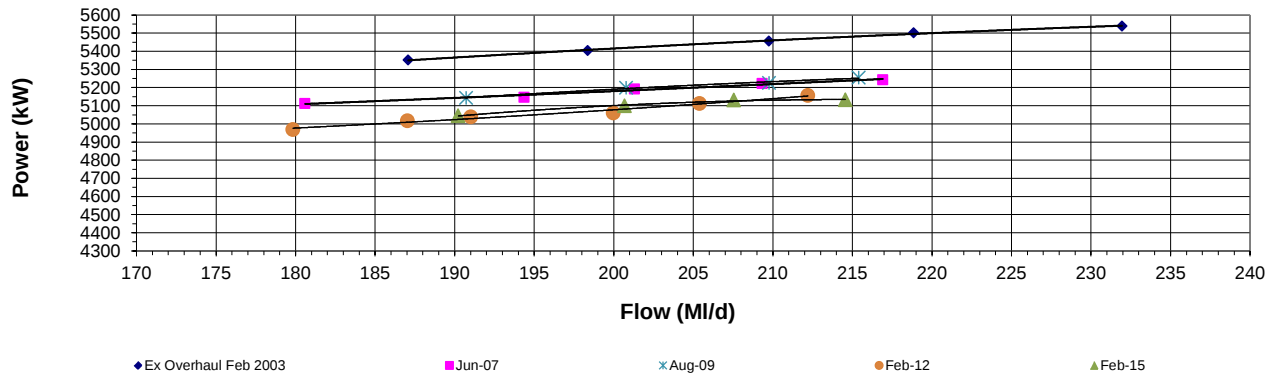
Q - H Curve (Set)

Zuikerbosch 23



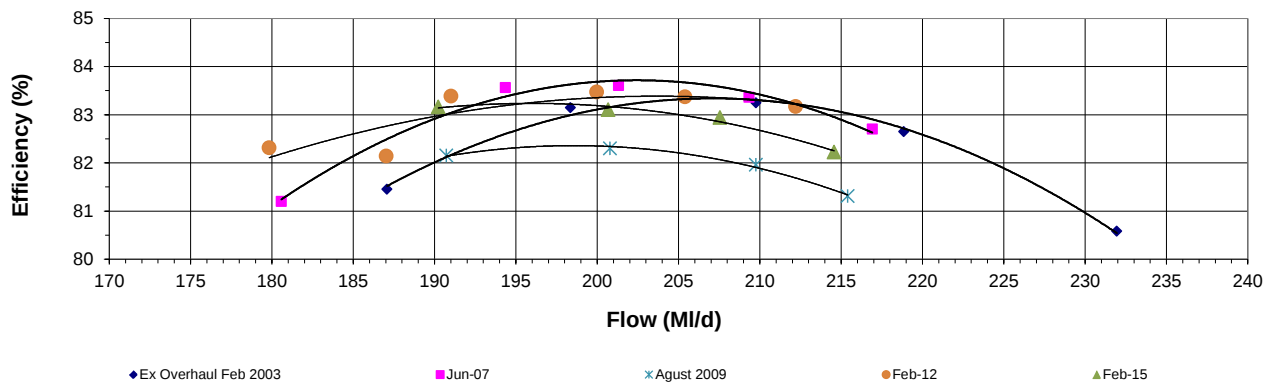
Q - kW Curve (Set)

Zuikerbosch 23



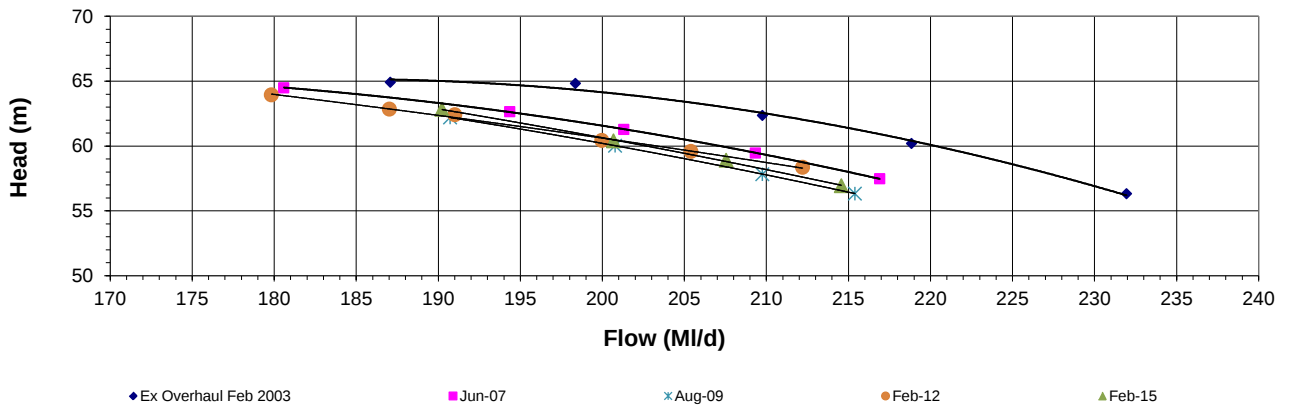
Q - Efficiency Curve (Set)

Zuikerbosch 23



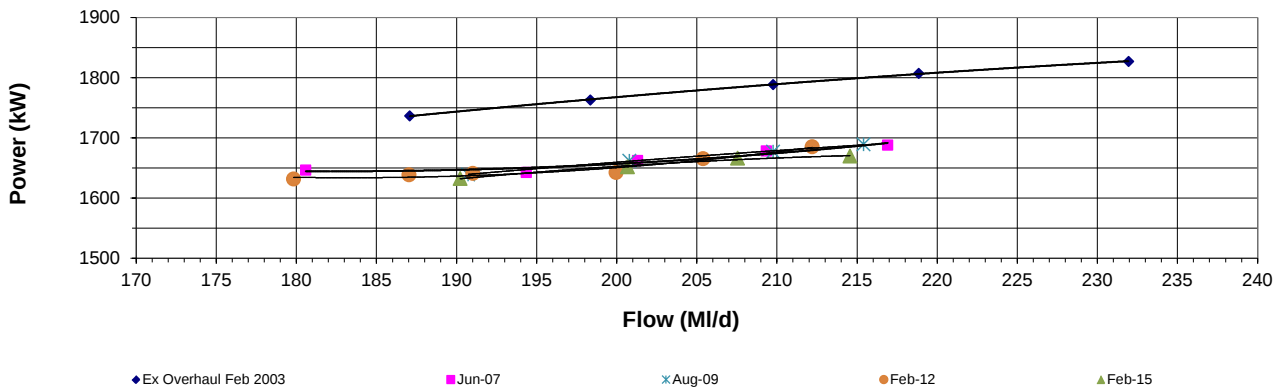
Q - H Curve (St 1)

Zuikerbosch 23



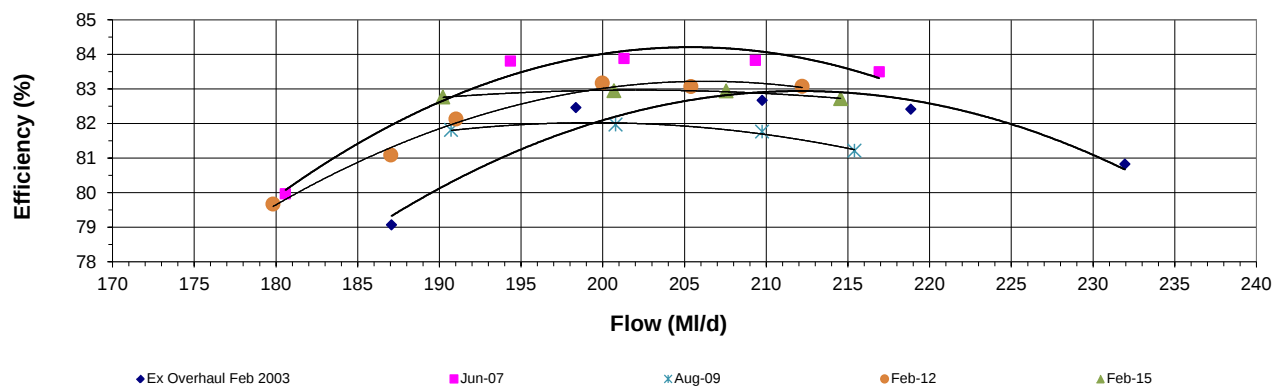
Q - kW Curve (St 1)

Zuikerbosch 23



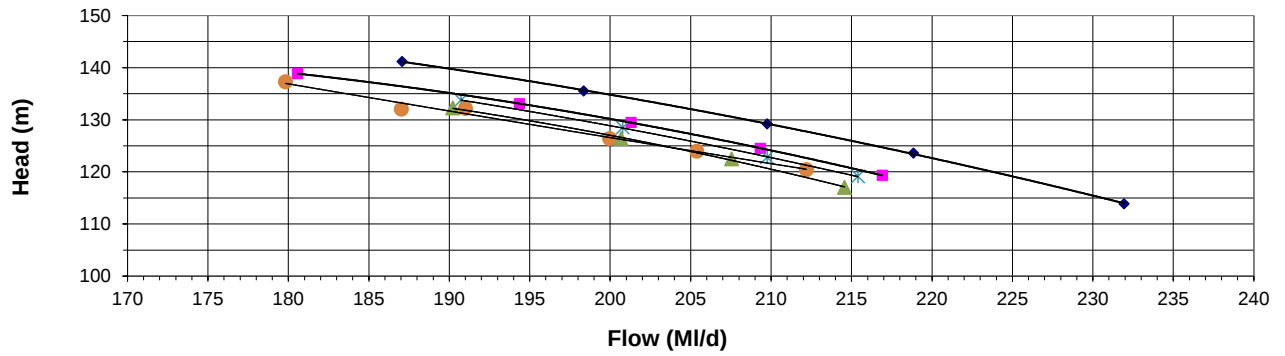
Q - Efficiency Curve (St 1)

Zuikerbosch 23



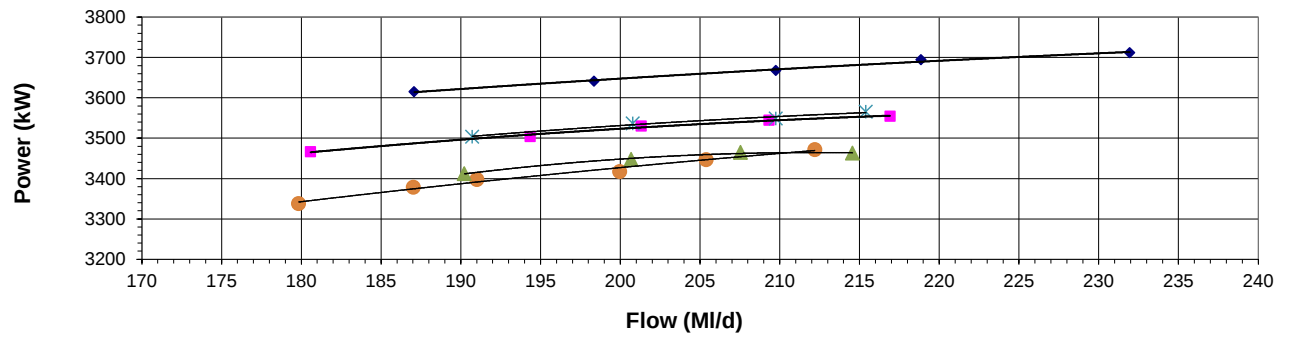
Q - H Curve (St 2)

Zuikerbosch 23



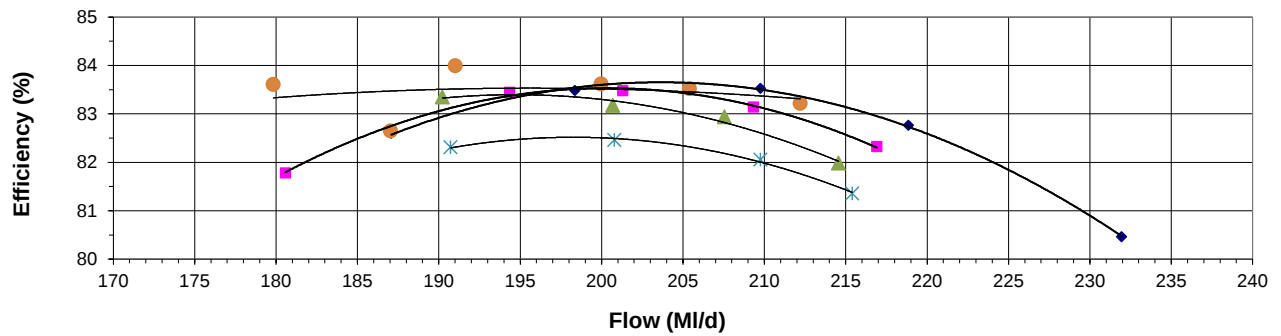
Q - kW Curve (St 2)

Zuikerbosch 23



Q - Efficiency Curve (St 2)

Zuikerbosch 23





07 March 2012

PERFORMANCE TEST CONDUCTED ON PUMP SET 23 IN ENGINE ROOM 4A AT ZUIKERBOCSH PUMPING STATION

THE FOLLOWING POINTS WERE DETERMINED FOR THE PUMP-SET:

1. Generated head at duty flow rate.
2. Pump power demand at duty flow rate.
3. Corresponding overall efficiency.

METHOD OF TESTING

Power Input Measurement

Electrical power demand of the pump-set was based on the two wattmeter method, using an electronic sub-standard energy meter.

Measurement of Flow Rate

The rate of flow was determined by measuring the differential pressure generated by a Venturi installed in the delivery pipeline of the pump-set using a calibrated differential pressure transmitter.

Head Measurement

The generated head of the pump-set was obtained from test pressure transmitters which were calibrated by an NLA traceable laboratory. Accuracy class of the test pressure transmitters is 0.25%.

RESULTS

The results of the test are shown on the attached copies of the following:

1. Pump test data sheets indicating all flow, head, power and efficiency characteristics of the pump-set as well as calculations for power demand at duty point
2. Characteristic curves for the pump-set, namely:
 - a) Quantity - Head
 - b) Quantity - Power
 - c) Quantity -Efficiency

SUMMARY OF PUMP-SET PERFORMANCE

DATE OF TEST:	28 February 2012
PUMPING STATION:	Zuikerbosch
PUMP-SET:	23
PUMP-SET DUTY:	200 Ml/d @ 185 m
OPERATING HOURS SINCE PREVIOUS TEST	8 541
TOTAL OPERATING HOURS	81 271

COMMENTS

Routine Test.

FLOW RATE AT DUTY GENERATED HEAD

After Overhaul (Ml/d)	TEST	DIFFERENCE	DEVIATION %
217.6	203.19	-14.41	-6.62

GENERATED HEAD AT DUTY FLOW

After Overhaul (m)	TEST	DIFFERENCE	DEVIATION %
198.97	187.19	-11.78	-5.92

PUMP-SET EFFICIENCY COMPARISON

After Overhaul (%)	TEST	DIFFERENCE	DEVIATION %
83.15	83.47	0.32	0.38

POWER DEMAND AT DUTY POINT

After Overhaul (kW)	TEST	DIFFERENCE	DEVIATION %
5030.64	5011.00	-19.64	-0.39

ECONOMIC EVALUATION TO OVERHAUL PUMP-SET

Date of last overhaul	July 2000
Operating hours since acceptance or overhaul	28 159
Pump-set utilization	34.51%
Interest rate	9.00%
Energy charge (R/kWh)	R 0.48
Monthly saving if pump-set efficiency is restored to original efficiency	R 0.00
NPV of saving in electrical cost if pump-set is restored to original efficiency	R 0.00

* If the cost to overhaul the pump-set exceeds this amount, the overhaul of the pump-set is not viable.

CONCLUSION

The performance of pump-set 23 is acceptable.

RECOMMENDATION

Pump-set 23 to be tested after a further 8000 operating hours.

Q van der Berg
PUMP TEST TECHNICIAN

P Lephuthing
PUMP TEST FITTER

R A N D W A T E R

PUMP TEST REPORT

Station:	Zuikerbosch
Engineroom:	4A
Pumps tested:	Pump-set 23
Date of test:	28 February 2012
Observer:	P Lephuthing

DETAILS ARE AS FOLLOWS :-

Contract Number		1387
Pump Manufacturer		MATHER & PLATT
Type of pump (Stage 1)		SDS DV 800/1000
Serial Number (Stage 1)		Not available
Motor Manufacturer (Stage 1)		ASEA
Serial Number (Stage 1)		7250-289
Rated Voltage (Stage 1 and 2)	(kV)	11000
Rated Power	(kW)	1705
Rated Amps	(A)	109
Type of pump (Stage 2)		SDS DV 700/800
Serial Number (Stage 2)		Not available
Motor Manufacturer (Stage 2)		BBC
Serial Number (Stage 2)		ZSM-0139
Rated Power	(kW)	3850
Rated Amps	(A)	235
Duty Flow Rate	(Ml/d)	200.00
Flow Meter Constant		13.7500
Duty Generated Head (Set)	(m)	185.00
Guaranteed Demand (set)	(kW)	4764.68
Guaranteed Efficiency	(%)	87.87
Duty Speed 1st Stage	(r.p.m.)	692.00
Duty Speed 2nd Stage	(r.p.m.)	1492.00
PT nom. ratio		11 000/110
CT ratio 1 st stage		120/1
CT ratio 2 nd stage		250/1
Suction Dia.	(mm)	1000.00
Delivery 1st Stage Dia.	(mm)	800.00
Delivery 2nd Stage Dia.	(mm)	900.00
Total Operating Hours		81 271
Operating Hours Since Overhaul		28 159
Return to Service After Last Overhaul		July 2000
Operating Hours Since Previous Test		8 541
Date of Previous Performance Test		August 2009
Density	(kg/m ³)	997.296
Gravity	(m/sec ²)	9.785
Pump-set Utilization	(%)	34.51

ZUIKERBOSCH PUMP SET 23
SITE READINGS ON SUBSTANDARD INSTRUMENTS :-

		Ex Overhaul April 2003					Routine Test June 2007					Routine Test August 2009				Routine Test February 2012					
		TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 1	TEST 2	TEST 3	TEST 4	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 6
Delivery valve position		1.00					1.00					1.00				1.00					
Voltage	(kV)	11.40	11.50	11.40	11.40	11.50	11.60	11.60	11.60	11.60	11.50	11.60	11.60	11.60	11.60	11.10	11.00	11.00	11.00	11.00	11.10
Frequency	(Hz)	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	49.90	50.00	50.00	50.00
Ammeter Readings 1st Stage	(A)	112.00	109.50	109.00	107.00	106.50	84.60	84.10	83.70	82.90	82.80	84.70	84.60	83.80	82.80	89.10	88.50	86.50	86.70	86.20	85.80
Ammeter Readings 2nd Stage	(A)	226.50	225.50	224.00	222.00	220.00	219.00	217.00	216.00	215.00	213.00	217.00	218.00	217.00	215.00	216.00	215.00	212.00	211.00	208.00	209.00
Energy Meter Stage 1	(kWh)	304.51	301.20	298.09	293.84	144.71	281.35	279.74	277.08	273.79	274.42	281.51	279.52	277.04	273.18	280.86	277.57	273.76	273.51	273.10	271.94
Energy Meter Stage 2	(kWh)	618.64	615.81	611.31	606.87	301.29	592.44	590.74	588.42	584.01	577.71	594.29	591.43	589.48	583.96	578.67	574.49	569.59	566.31	563.09	556.32
Time	(sec.)	600.00	600.00	600.00	600.00	300.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00
Manometer Diff Head	(M/d)	284.560	253.333	232.720	208.110	185.105	248.872	231.781	214.349	199.804	172.488	245.417	232.725	213.236	192.405	238.183	223.134	211.498	192.986	185.017	171.043
Delivery Pressure 2nd Stage	(kPa)	1706.17	1840.20	1916.82	2004.29	2061.61	1782.49	1852.72	1919.26	1966.57	2041.47	1761.55	1812.44	1890.68	1964.46	1791.16	1839.89	1872.59	1948.63	1952.03	2013.76
Delivery Pressure 1st Stage	(kPa)	588.30	628.17	650.51	676.36	678.92	612.20	632.08	650.33	663.01	681.98	593.37	608.73	631.71	654.45	610.33	624.67	633.89	654.12	658.62	669.69
Suction Pressure	(kPa)	46.63	47.69	48.35	49.28	50.25	58.14	58.21	58.15	56.90	57.12	50.42	50.78	51.71	52.65	47.40	49.32	49.87	50.17	50.27	50.19
Speed 1st Stage	(r.p.m.)	744.50	743.00	743.00	743.00	743.00	744.00	745.00	744.00	744.00	744.00	744.00	744.00	744.00	744.00	744.00	744.00	740.00	742.00	743.00	744.00
Speed 2nd Stage	(r.p.m.)	1498.00	1495.00	1496.00	1495.00	1496.00	1497.00	1496.00	1497.00	1495.00	1497.00	1496.00	1497.00	1496.00	1495.00	1498.00	1498.00	1491.00	1493.00	1496.00	1498.00

CALCULATED RESULTS 1st & 2nd STAGE:

		TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 1	TEST 2	TEST 3	TEST 4	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 6
Motor Current 1st Stage	(A)	112.00	109.50	109.00	107.00	106.50	84.60	84.10	83.70	82.90	82.80	84.70	84.60	83.80	82.80	89.10	88.50	86.50	86.70	86.20	85.80
Motor Current 2nd Stage	(A)	226.50	225.50	224.00	222.00	220.00	219.00	217.00	216.00	215.00	213.00	217.00	218.00	217.00	215.00	216.00	215.00	212.00	211.00	208.00	209.00
Stage kW 1st stage	(kW)	1827.06	1807.20	1788.54	1763.04	1736.52	1688.10	1678.44	1662.48	1642.74	1646.52	1689.06	1677.12	1662.24	1639.08	1685.16	1665.42	1642.56	1641.06	1638.60	1631.64
Stage kW 2nd stage	(kW)	3711.84	3694.86	3667.86	3641.22	3615.48	3554.64	3544.44	3530.52	3504.06	3466.26	3565.74	3548.58	3536.88	3503.76	3472.02	3446.94	3417.54	3397.86	3378.54	3337.92
Set kW	(kW)	5538.90	5502.06	5456.40	5404.26	5352.00	5242.74	5222.88	5193.00	5146.80	5112.78	5254.80	5225.70	5199.12	5142.84	5157.18	5112.36	5060.10	5038.92	5017.14	4969.56
Flow	(M/d)	231.947	218.851	209.758	198.358	187.073	216.916	209.335	201.309	194.359	180.585	215.405	209.761	200.786	190.726	212.206	205.393	199.966	191.014	187.029	179.827
Velocity Head 1st Stage	(m)	0.861	0.767	0.704	0.630	0.560	0.753	0.702	0.649	0.605	0.522	0.743	0.704	0.645	0.582	0.721	0.675	0.640	0.584	0.560	0.518
Generated Head 1st Stage	(m)	56.319	60.197	62.355	64.831	64.924	57.478	59.454	61.277	62.659	64.497	56.331	57.828	60.027	62.195	58.355	59.581	60.432	62.417	62.844	63.943
Velocity Head 2nd Stage	(m)	-0.548	-0.488	-0.448	-0.401	-0.357	-0.479	-0.446	-0.413	-0.385	-0.332	-0.473	-0.448	-0.411	-0.371	-0.459	-0.430	-0.407	-0.372	-0.356	-0.329
Generated Head 2nd Stage	(m)	113.900	123.601	129.198	135.554	141.205	119.336	124.525	129.502	133.075	138.854	119.127	122.789	128.483	133.750	120.436	123.985	126.412	132.162	132.064	137.278
Total Generated Head	(m)	170.218	183.797	191.552	200.385	206.129	176.814	183.979	190.779	195.734	203.350	175.458	180.617	188.511	195.946	178.791	183.566	186.845	194.578	194.908	201.221
Water kW 1st Stage	(kW)	1476.75	1489.32	1478.61	1453.78	1373.04	1409.48	1406.99	1394.53	1376.75	1316.70	1371.74	1371.28	1362.53	1341.01	1399.92	1383.44	1366.13	1347.82	1328.73	1299.92
Water kW 2nd Stage	(kW)	2986.61	3057.99	3063.66	3039.68	2986.26	2926.38	2946.89	2947.17	2923.92	2834.69	2900.89	2911.72	2916.40	2883.85	2889.22	2878.87	2857.67	2853.90	2792.28	2790.76
Water kW	(kW)	4463.37	4547.31	4542.27	4493.46	4359.30	4335.86	4353.88	4341.70	4300.68	4151.39	4272.63	4283.01	4278.93	4224.86	4289.14	4262.31	4223.79	4201.71	4121.01	4090.68
Efficiency 1st Stage	(%)	80.83	82.41	82.67	82.46	79.07	83.49	83.83	83.88	83.81	79.97	81.21	81.76	81.97	81.82	83.07	83.07	83.17	82.13	81.09	79.67
Efficiency 2nd Stage	(%)	80.46	82.76	83.53	83.48	82.60	82.33	83.14	83.48	83.44	81.78	81.35	82.05	82.46	82.31	83.21	83.52	83.62	83.99	82.65	83.61
Overall Efficiency	(%)	80.58	82.65	83.25	83.15	81.45	82.70	83.36	83.61	83.56	81.20	81.31	81.96	82.30	82.15	83.17	83.37	83.47	83.39	82.14	82.31

SUMMARISED TEST RESULTS FOR PUMP SET :-

Set kW	(kW)	5538.90	5502.06	5456.40	5404.26	5352.00	5242.74	5222.88	5193.00	5146.80	5112.78	5254.80	5225.70	5199.12	5142.84	5157.18	5112.36	5060.10	5038.92	5017.14	4969.56
Water kW	(kW)	4463.37	4547.31	4542.27	4493.46	4359.30	4335.86	4353.88	4341.70	4300.68	4151.39	4272.63	4283.01	4278.93	4224.86	4289.14	4262.31	4223.79	4201.71	4121.01	4090.68
Total Generated Head	(m)	170.22	183.80	191.55	200.39	206.13	176.81	183.98	190.78	195.73	203.35	175.46	180.62	188.51	195.95	178.79	183.57	186.84	194.58	194.91	201.22
Flow	(M/d)	231.95	218.85	209.76	198.36	187.07	216.92	209.33	201.31	194.36	180.59	215.40	209.76	200.79	190.73	212.21	205.39	199.97	191.01	187.03	179.83

Set Efficiency	(%)	80.58	82.65	83.25	83.15	81.45	82.70	83.36	83.61	83.56	81.20	81.31	81.96	82.30	82.15	83.17	83.37	83.47	83.39	82.14	82.31
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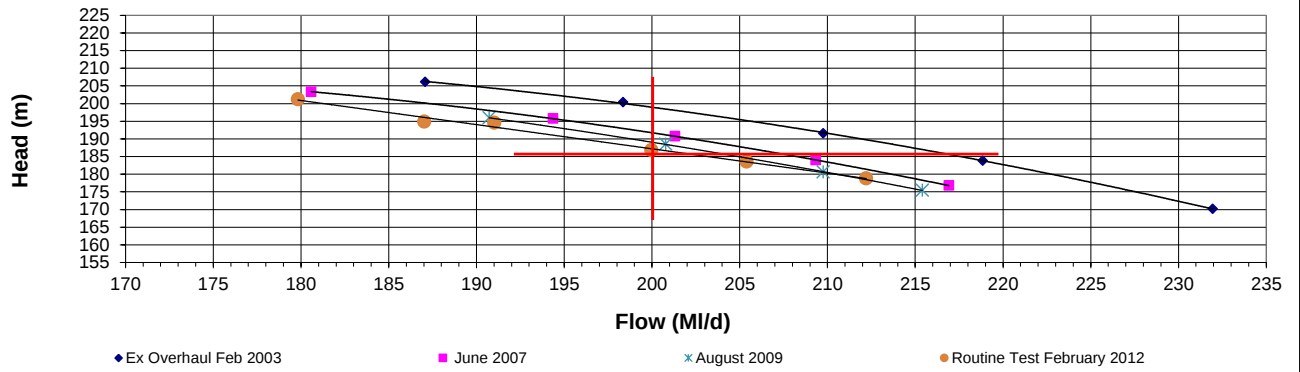
CALCULATED POWER AT DUTY POINT:-

Calculations are based on test with the flow rate nearest to duty point

Flow rate used:				198.36	M/d				201.31	M/d				200.79	M/d			199.97	M/d		
Efficiency at this point				83.15	%				83.61	%				82.30	%			83.47	%		
Power demand at duty point				5030.64	kW				5002.96	kW				5082.33	kW			5011.00	kW		
Percentage of guaranteed demand				105.58	%				105.00	%				106.67	%			105.17	%		

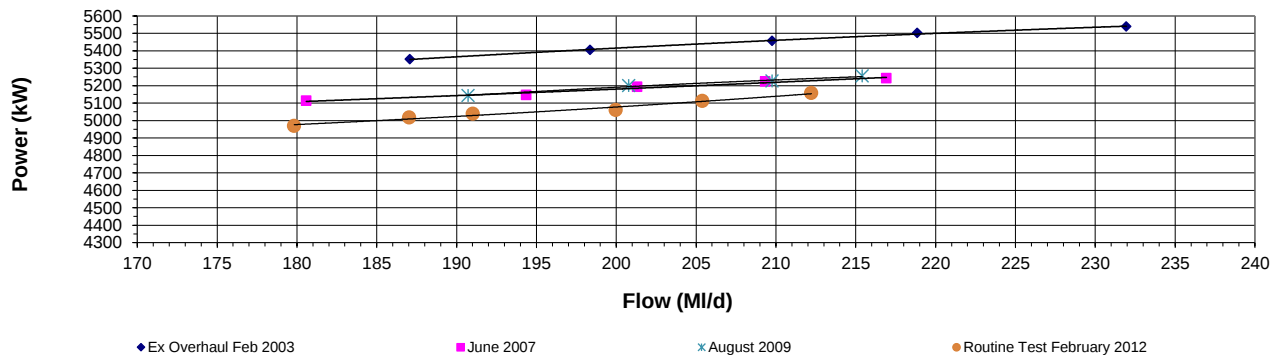
Q - H Curve (Set)

Zuikerbosch 23



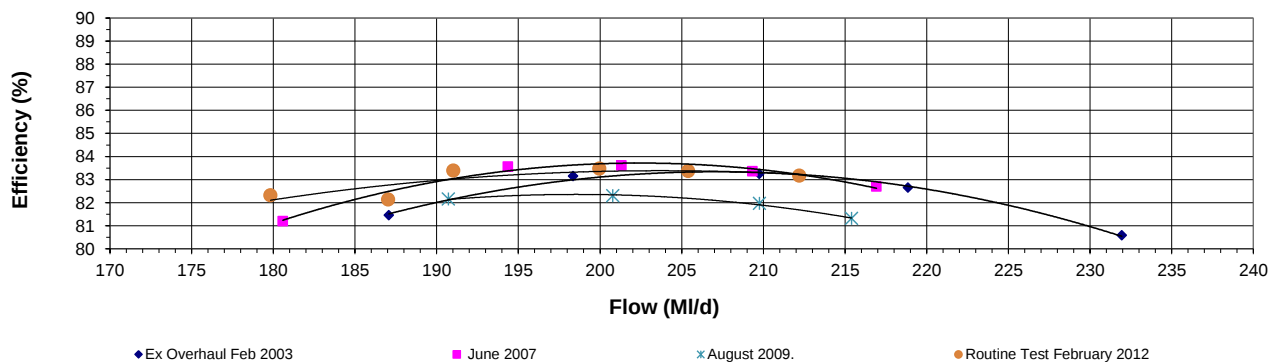
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Zuikerbosch 23



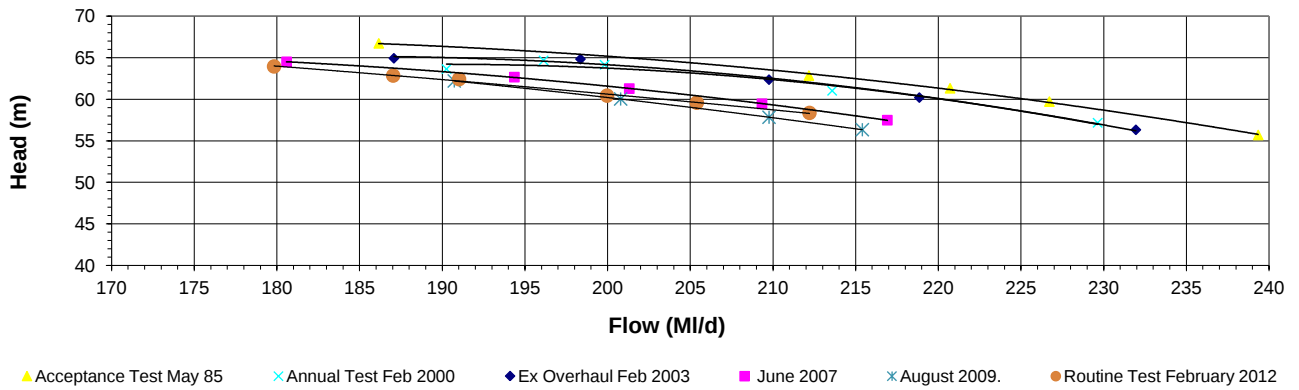
Q - Efficiency Curve (Set)

Zuikerbosch 23



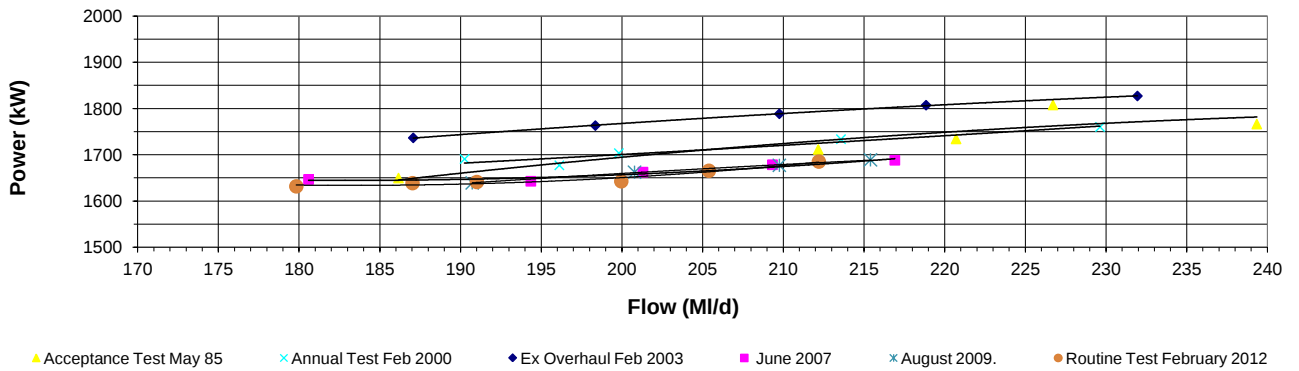
Q - H Curve (St 1)

Zuikerbosch 23



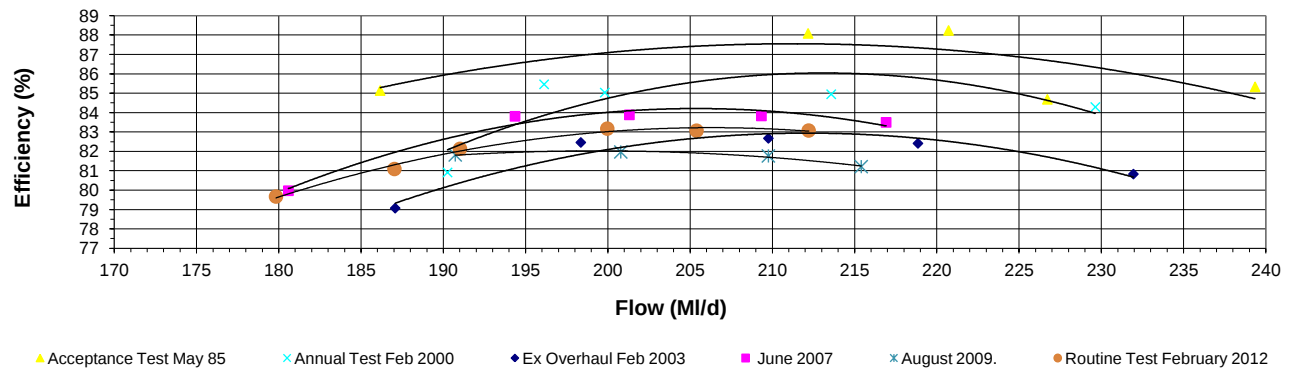
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Zuikerbosch 23



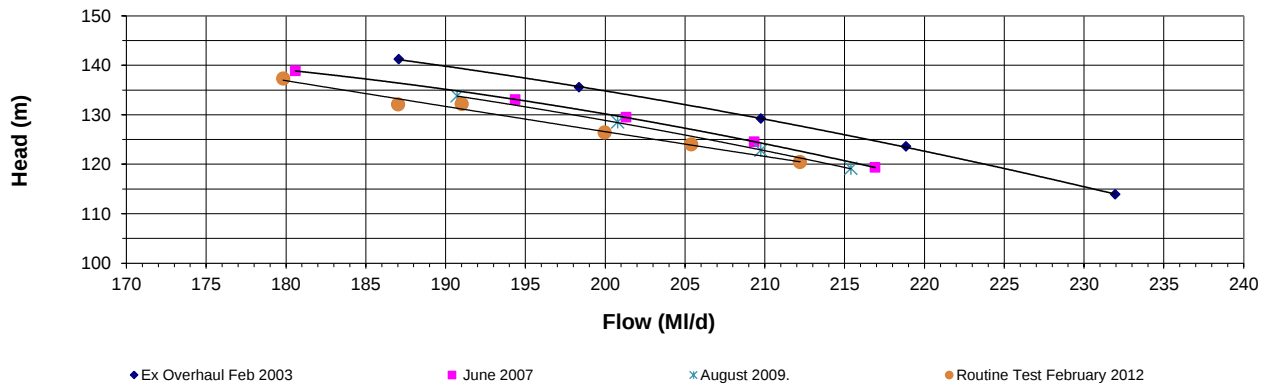
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Zuikerbosch 23



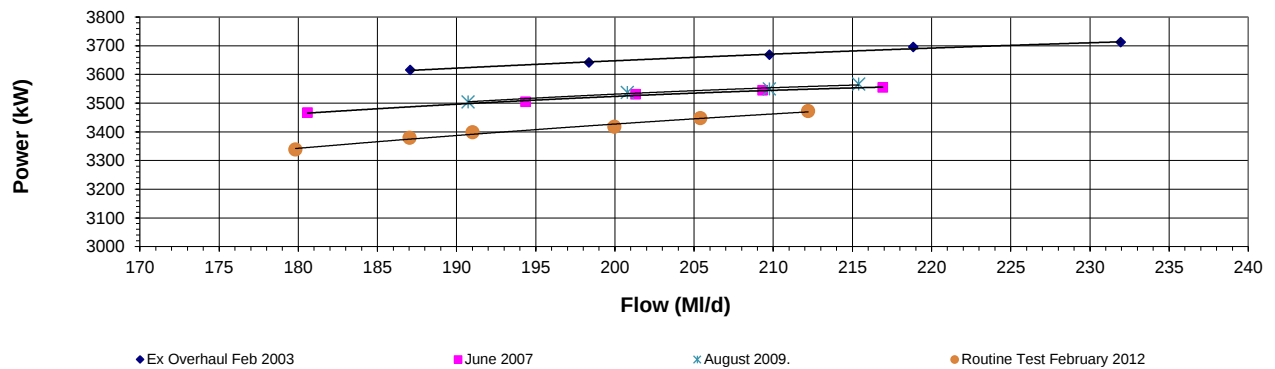
Q - H Curve (St 2)

Zuikerbosch 23



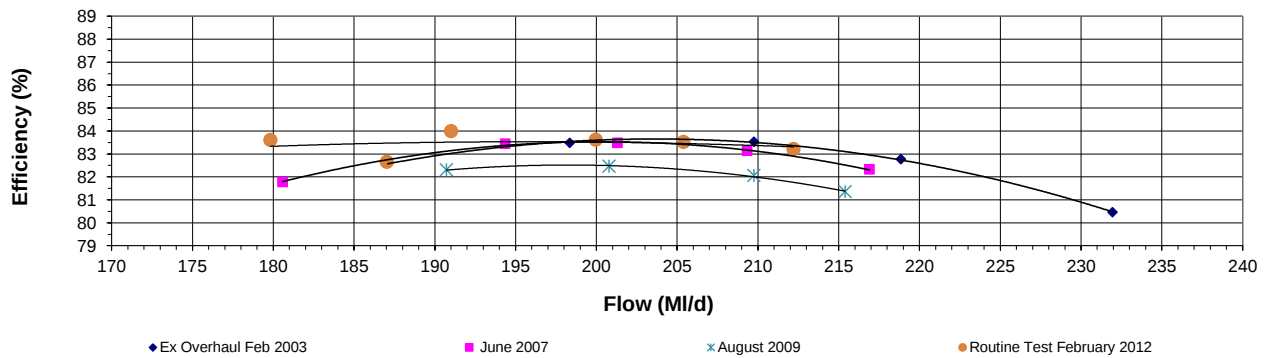
Q - kW Curve (St 2)

Zuikerbosch 23



Q - Efficiency Curve (St 2)

Zuikerbosch 23





To: See Distribution List

From: Pump Test Technician

Date: 01 October 2009

Distribution List

Process Manager - Operations

Mechanical Engineer - Process

Manager - Zuikerbosch Pumping Station

Maintenance Manager - Zuikerbosch Pumping Station

Operations Manager - Zuikerbosch Pumping Station

Planning Office Works Area 2 - Zuikerbosch Pumping Station

PERFORMANCE TEST CONDUCTED ON PUMP-SET 23 IN ENGINE ROOM 4A AT ZUIKERBOSCH PUMPING STATION.

Object

Routine test.

The following points were determined:

1. Generated head at duty flow rate.
2. Pump power demand at this flow.
3. Corresponding overall efficiency.

METHOD OF TESTING

Power Input Measurement

Electrical power demand of the pump-set was based on the two wattmeter method, using an electronic sub-standard energy meter.

Measurement of Flow Rate

The rate of flow was determined by measuring the differential pressure generated by a Venturi meter in the delivery pipeline of the pump set using a calibrated differential pressure transmitter.

Head Measurement

Pump generated head was obtained from test pressure transmitters calibrated by an NLA traceable laboratory.

Results

The results of these tests are shown on the attached copies of the following:

1. Pump test data sheet indicating all flows, heads, powers and efficiencies of the pump set as well as calculations for power demand at duty point.
2. Characteristic curves for the pump-set, namely:
 - a) Quantity - Head
 - b) Quantity - Power
 - c) Quantity -Efficiency

Comments

Operating Hours

Pump-set 23 has completed 72 730 operating hours. The pump-set was returned to service during July 2002 after overhaul and has completed 19 618 operating hours since overhaul.

The utilisation of pump-set 23 during the period April 1997 to August 2009 was 33.79%.

Performance

The pump-set delivers 204.92 Ml/d at the duty generated head of 185 metres. The efficiency of the pump-set at the duty rate of flow is 82.30%.

Economic Viability Study

The following criterion was used in an economic viability evaluation to determine whether it is economically viable to overhaul pump-set 23.

- a) Pump set utilisation of 33.79%.
- b) Interest rate of 9.00%.
- c) The average energy charge of 30.40 cents per kWh as supplied by the statistician from the ZUIKERBOSCH accounts.
- d) Initial monthly saving of R 3,950.40 if the pump-set efficiency at duty is restored to an efficiency of 83.15%.

Conclusion

The net present value of the savings per month if the pump set is restored to an efficiency of 83.15% is R 50,394.99. Since the cost of overhauling the pump-set exceeds this amount, it is not economically viable to overhaul the pump-set.

Recommendations

Pump set 23 to be tested after a further 8000 operating hours.

Q van der Berg
Operations (Process)

R A N D W A T E R

PUMP TEST REPORT

Station:	Zuikerbosch
Engineroom:	4A
Pumps tested:	Pump-set 23
Date of test:	19 August 2009
Observer:	P Lephuthing

DETAILS ARE AS FOLLOWS :-

Contract Number		1387
Pump Manufacturer		MATHER & PLATT
Type of pump (Stage 1)		SDS DV 800/1000
Serial Number (Stage 1)		Not available
Motor Manufacturer (Stage 1)		ASEA
Serial Number (Stage 1)		7250-289
Rated Voltage (Stage 1 and 2)	(kV)	11000
Rated Power	(kW)	1705
Rated Amps	(A)	109
Type of pump (Stage 2)		SDS DV 700/800
Serial Number (Stage 2)		Not available
Motor Manufacturer (Stage 2)		BBC
Serial Number (Stage 2)		ZSM-0139
Rated Power	(kW)	3850
Rated Amps	(A)	235
Duty Flow Rate	(Ml/d)	200.00
Flow Meter Constant		13.7500
Duty Generated Head (Set)	(m)	185.00
Guaranteed Demand (set)	(kW)	4764.68
Guaranteed Efficiency	(%)	87.87
Duty Speed 1st Stage	(r.p.m.)	692.00
Duty Speed 2nd Stage	(r.p.m.)	1492.00
PT nom. ratio		11 000/110
CT ratio 1 st stage		120/1
CT ratio 2 nd stage		250/1
Suction Dia.	(mm)	1000.00
Delivery 1st Stage Dia.	(mm)	800.00
Delivery 2nd Stage Dia.	(mm)	900.00
Total Operating Hours		72 730
Operating Hours Since Overhaul		19 618
Return to Service After Last Overhaul		July 2000
Operating Hours Since Previous Test		7 748
Date of Previous Performance Test		June 2007
Density	(kg/m ³)	997.296
Gravity	(m/sec ²)	9.785

ZUIKERBOSCH PUMP SET 23

SITE READINGS ON SUBSTANDARD INSTRUMENTS :-

		Ex Overhaul April 2003					Routine Test June 2007					Routine Test August 2009			
		TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 1	TEST 2	TEST 3	TEST 4
Delivery valve position		100%					100%					100%			
Voltage	(kV)	11.40	11.50	11.40	11.40	11.50	11.60	11.60	11.60	11.60	11.50	11.60	11.60	11.60	11.60
Frequency	(Hz)	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Ammeter Readings 1st Stage	(A)	112.00	109.50	109.00	107.00	106.50	84.60	84.10	83.70	82.90	82.80	84.70	84.60	83.80	82.80
Ammeter Readings 2nd Stage	(A)	226.50	225.50	224.00	222.00	220.00	219.00	217.00	216.00	215.00	213.00	217.00	218.00	217.00	215.00
Energy Meter Stage 1	(kWh)	304.51	301.20	298.09	293.84	144.71	281.35	279.74	277.08	273.79	274.42	281.51	279.52	277.04	273.18
Energy Meter Stage 2	(kWh)	618.64	615.81	611.31	606.87	301.29	592.44	590.74	588.42	584.01	577.71	594.29	591.43	589.48	583.96
Time	(sec.)	600.00	600.00	600.00	600.00	300.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00
Manometer Diff Head	(MI/d)	284.560	253.333	232.720	208.110	185.105	248.872	231.781	214.349	199.804	172.488	245.417	232.725	213.236	192.405
Delivery Pressure 2nd Stage	(kPa)	1706.17	1840.20	1916.82	2004.29	2061.61	1782.49	1852.72	1919.26	1966.57	2041.47	1761.55	1812.44	1890.68	1964.46
Delivery Pressure 1st Stage	(kPa)	588.30	628.17	650.51	676.36	678.92	612.20	632.08	650.33	663.01	681.98	593.37	608.73	631.71	654.45
Suction Pressure	(kPa)	46.63	47.69	48.35	49.28	50.25	58.14	58.21	58.15	56.90	57.12	50.42	50.78	51.71	52.65
Speed 1st Stage	(r.p.m.)	744.50	743.00	743.00	743.00	743.00	744.00	745.00	744.00	744.00	744.00	744.00	744.00	744.00	744.00
Speed 2nd Stage	(r.p.m.)	1498.00	1495.00	1496.00	1495.00	1496.00	1497.00	1496.00	1497.00	1495.00	1497.00	1496.00	1497.00	1496.00	1495.00

CALCULATED RESULTS 1st & 2nd STAGE:

		TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 1	TEST 2	TEST 3	TEST 4
Motor Current 1st Stage	(A)	112.00	109.50	109.00	107.00	106.50	84.60	84.10	83.70	82.90	82.80	84.70	84.60	83.80	82.80
Motor Current 2nd Stage	(A)	226.50	225.50	224.00	222.00	220.00	219.00	217.00	216.00	215.00	213.00	217.00	218.00	217.00	215.00
Stage kW 1st stage	(kW)	1827.06	1807.20	1788.54	1763.04	1736.52	1688.10	1678.44	1662.48	1642.74	1646.52	1689.06	1677.12	1662.24	1639.08
Stage kW 2nd stage	(kW)	3711.84	3694.86	3667.86	3641.22	3615.48	3554.64	3544.44	3530.52	3504.06	3466.26	3565.74	3548.58	3536.88	3503.76
Set kW	(kW)	5538.90	5502.06	5456.40	5404.26	5352.00	5242.74	5222.88	5193.00	5146.80	5112.78	5254.80	5225.70	5199.12	5142.84
Flow	(MI/d)	231.947	218.851	209.758	198.358	187.073	216.916	209.335	201.309	194.359	180.585	215.405	209.761	200.786	190.726
Velocity Head 1st Stage	(m)	0.861	0.767	0.704	0.630	0.560	0.753	0.702	0.649	0.605	0.522	0.743	0.704	0.645	0.582
Generated Head 1st Stage	(m)	56.319	60.197	62.355	64.831	64.924	57.478	59.454	61.277	62.659	64.497	56.331	57.828	60.027	62.195
Velocity Head 2nd Stage	(m)	-0.548	-0.488	-0.448	-0.401	-0.357	-0.479	-0.446	-0.413	-0.385	-0.332	-0.473	-0.448	-0.411	-0.371
Generated Head 2nd Stage	(m)	113.900	123.601	129.198	135.554	141.205	119.336	124.525	129.502	133.075	138.854	119.127	122.789	128.483	133.750
Total Generated Head	(m)	170.218	183.797	191.552	200.385	206.129	176.814	183.979	190.779	195.734	203.350	175.458	180.617	188.511	195.946
Water kW 1st Stage	(kW)	1476.75	1489.32	1478.61	1453.78	1373.04	1409.48	1406.99	1394.53	1376.75	1316.70	1371.74	1371.28	1362.53	1341.01
Water kW 2nd Stage	(kW)	2986.61	3057.99	3063.66	3039.68	2986.26	2926.38	2946.89	2947.17	2923.92	2834.69	2900.89	2911.72	2916.40	2883.85
Water kW	(kW)	4463.37	4547.31	4542.27	4493.46	4359.30	4335.86	4353.88	4341.70	4300.68	4151.39	4272.63	4283.01	4278.93	4224.86
Efficiency 1st Stage	(%)	80.83	82.41	82.67	82.46	79.07	83.49	83.83	83.88	83.81	79.97	81.21	81.76	81.97	81.82
Efficiency 2nd Stage	(%)	80.46	82.76	83.53	83.48	82.60	82.33	83.14	83.48	83.44	81.78	81.35	82.05	82.46	82.31
Overall Efficiency	(%)	80.58	82.65	83.25	83.15	81.45	82.70	83.36	83.61	83.56	81.20	81.31	81.96	82.30	82.15

SUMMARISED TEST RESULTS FOR PUMP SET :-

Set kW	(kW)	5538.90	5502.06	5456.40	5404.26	5352.00	5242.74	5222.88	5193.00	5146.80	5112.78	5254.80	5225.70	5199.12	5142.84
Water kW	(kW)	4463.37	4547.31	4542.27	4493.46	4359.30	4335.86	4353.88	4341.70	4300.68	4151.39	4272.63	4283.01	4278.93	4224.86
Total Generated Head	(m)	170.22	183.80	191.55	200.39	206.13	176.81	183.98	190.78	195.73	203.35	175.46	180.62	188.51	195.95
Flow	(MI/d)	231.95	218.85	209.76	198.36	187.07	216.92	209.33	201.31	194.36	180.59	215.40	209.76	200.79	190.73
Set Efficiency	(%)	80.58	82.65	83.25	83.15	81.45	82.70	83.36	83.61	83.56	81.20	81.31	81.96	82.30	82.15

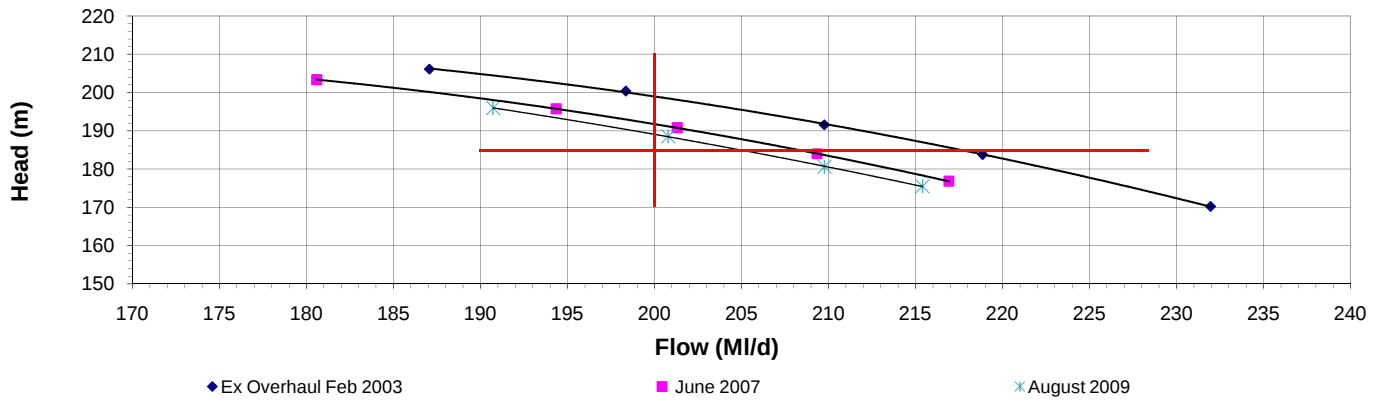
CALCULATED POWER AT DUTY POINT:-

Calculations are based on test with the flow rate nearest to duty point

Flow rate used:				198.36	MI/d				201.31	MI/d				200.79	MI/d
Efficiency at this point				83.15	%				83.61	%				82.30	%
Power demand at duty point				5030.64	kW				5002.96	kW				5082.33	kW
Percentage of guaranteed demand				105.58	%				105.00	%				106.67	%

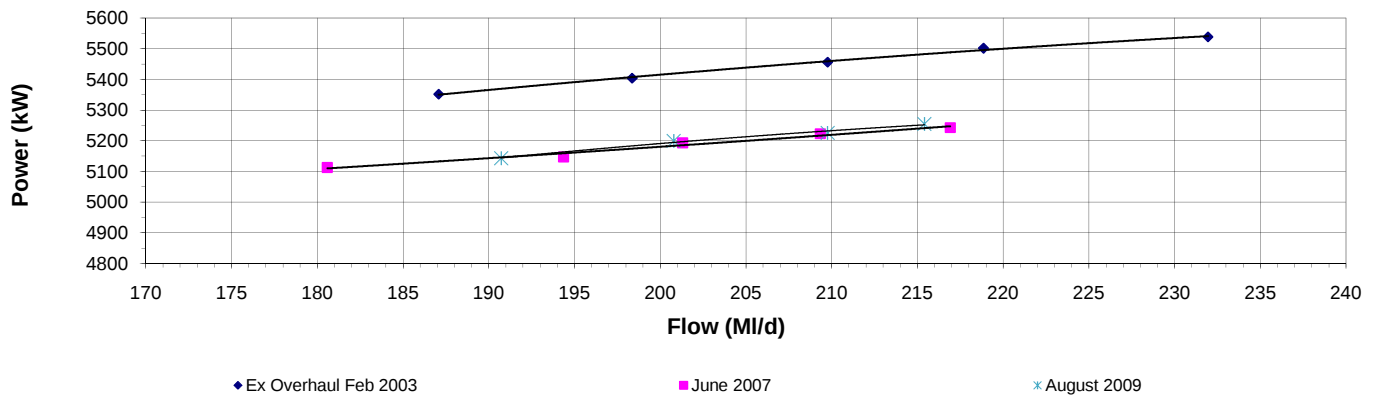
Q - H Curve (Set)

Zuikerbosch 23



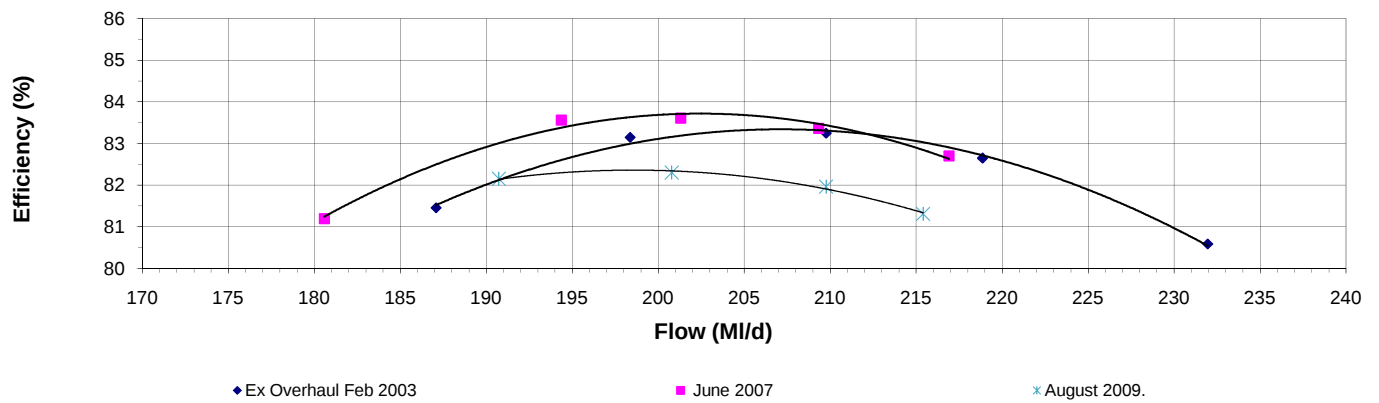
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Zuikerbosch 23



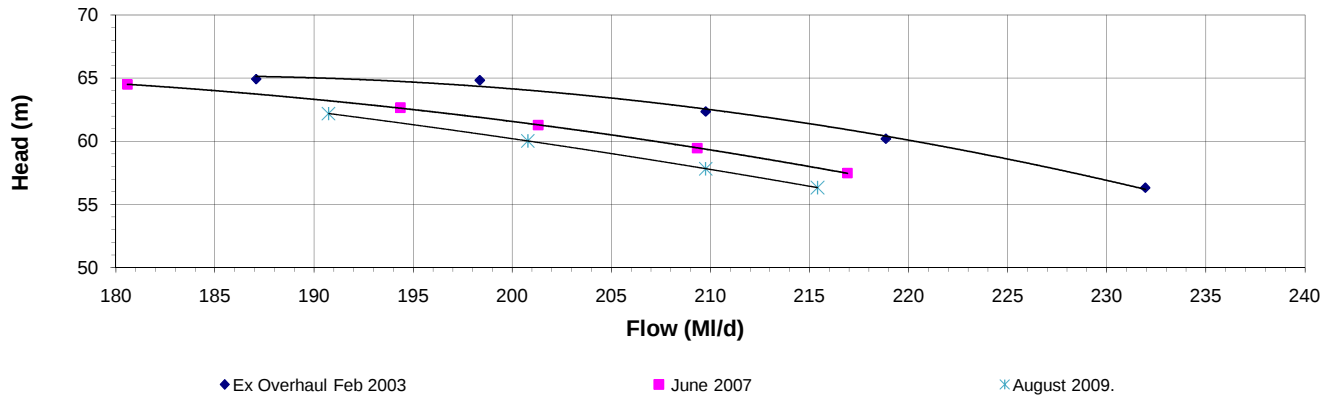
Q - Efficiency Curve (Set)

Zuikerbosch 23



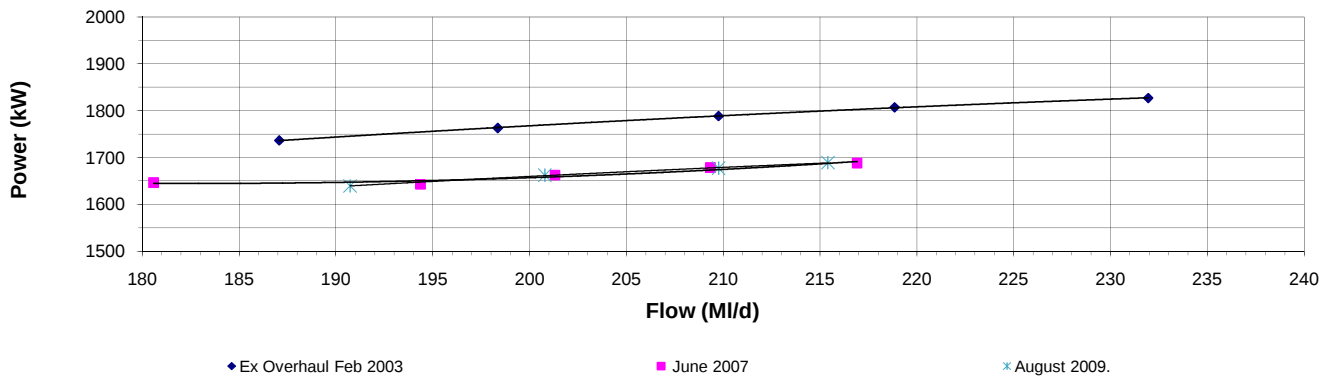
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Zuikerbosch 23



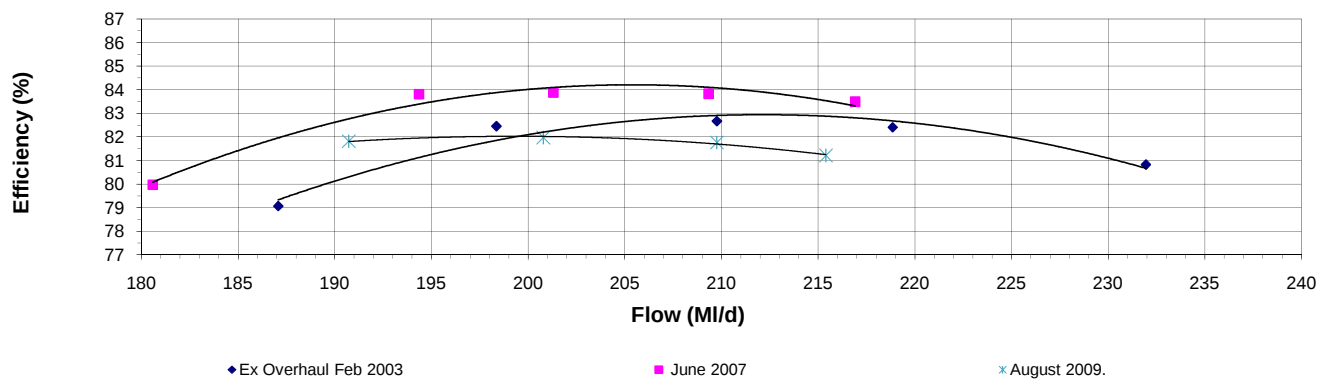
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Zuikerbosch 23



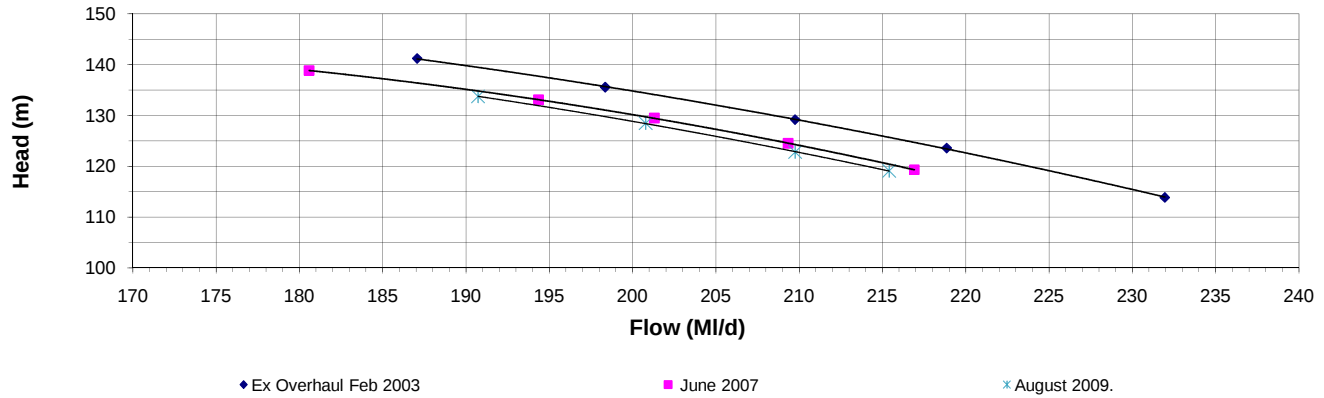
Q - Efficiency Curve (St 1)

Zuikerbosch 23



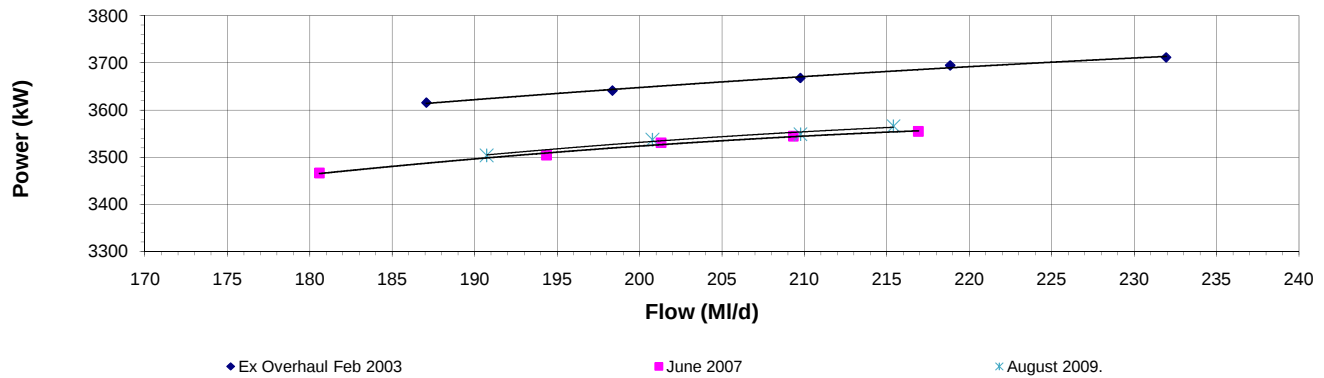
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Zuikerbosch 23



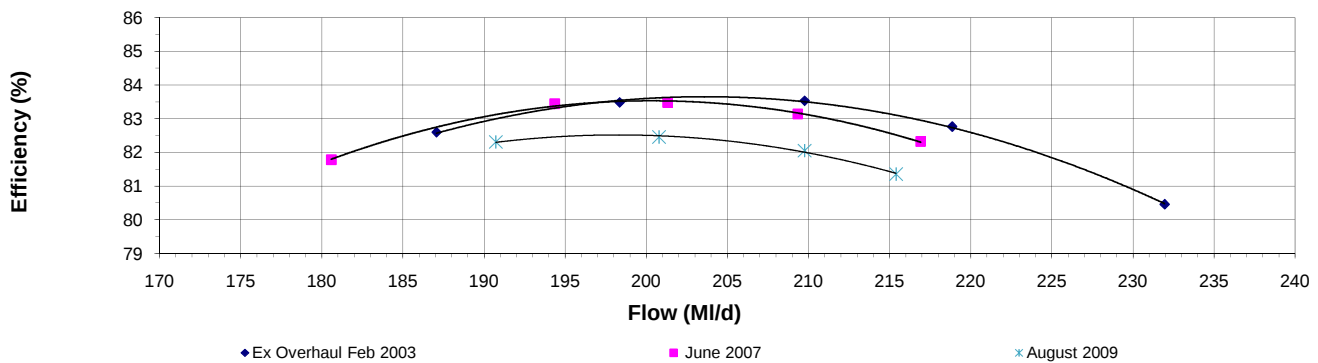
Q - kW Curve (St 2)

Zuikerbosch 23



Q - Efficiency Curve (St 2)

Zuikerbosch 23





To: See Distribution List

From: Pump Test Technician

Date: 03 July 2007

Distribution List

General Manager – Operations

Chief Operations Engineer - Process

Chief Operations Engineer - Electrical

Chief Operations Engineer - Mechanical

Mechanical Engineer - Process

Planning Engineer

Manager – Zuikerbosch pumping station

Operations Manager – Zuikerbosch pumping station

Maintenance Manager – Zuikerbosch pumping station

Planning Officer - Zuikerbosch pumping station

**ROUTINE TEST CONDUCTED ON PUMP-SET 23 IN ENGINE ROOM 4A AT
ZUIKERBOSCH PUMPING STATION**

The following points were determined for the pump-set:

1. Generated head at duty flow rate.
2. Pump power demand at this flow.
3. Corresponding overall efficiency.

METHOD OF TESTING

Power Input Measurement

Electrical power demand of the pump-set was based on the two wattmeter method, using an electronic sub-standard energy meter.

Measurement of Flow Rate

A calibrated Yokogawa differential pressure transmitter was used to determine the differential pressure generated by the pump-set venturi.

Head Measurement

The generated head of the pump-set was obtained from test pressure transducers calibrated by an NLA traceable laboratory.

Results

The results of the test are shown on the attached copies of the following:

1. Pump test data sheet indicating all flows, heads, powers and efficiencies of the pump-set as well as calculations for power demand at duty point.
2. Characteristic curves for the pump-set, namely:
 - a) Quantity - Head
 - b) Quantity - Power
 - c) Quantity -Efficiency

Comments

General

Pump-set 23 was returned to service during July 2000 after overhaul.

Operating Hours

The utilization of pump-set 23 between April 1997 and June 2007 was 33.36%.

Total operating hours for the pump-set: 64 982.

Operating hours since overhaul: 11 870.

Performance

Quantity – Head:

The pump set delivers 208.00 Ml/d at the design head of 185 metres.

Quantity – kW:

Power consumption for the pump set at the design duty is 5 002.96 kW.

Quantity - Efficiency:

The efficiency of the pump set at the design duty is 83.61%.

Conclusion

The performance of pump-set 23 is acceptable.

Recommendations

Zuikerbosch pump-set 23 to be tested after a further 8000 operating hours.

Q van der Berg
Operations (Process)

R A N D W A T E R

PUMP TEST REPORT

Station:	Zuikerbosch
Engineroom:	4A
Pumps tested:	Pump set No 23
Date of test:	5 June 2007
Observer:	Q. van der Berg

DETAILS ARE AS FOLLOWS :-

Contract Number		1387
Pump Manufacturer		MATHER & PLATT
Type of pump (Stage 1)		SDS DV 800/1000
Serial Number (Stage 1)		Not available
Motor Manufacturer (Stage 1)		ASEA
Serial Number (Stage 1)		7250-289
Rated Voltage (Stage 1 and 2)	(kV)	11000
Rated Power	(kW)	1705
Rated Amps	(A)	109
Type of pump (Stage 2)		SDS DV 700/800
Serial Number (Stage 2)		Not available
Motor Manufacturer (Stage 2)		BBC
Serial Number (Stage 2)		ZSM-0139
Rated Power	(kW)	3850
Rated Amps	(A)	235
Duty Flow Rate	(Ml/d)	200.00
Flow Meter Constant		13.7500
Duty Generated Head (Set)	(m)	185.00
Guaranteed Demand (set)	(kW)	4764.68
Guaranteed Efficiency	(%)	87.87
Duty Speed 1st Stage	(r.p.m.)	692.00
Duty Speed 2nd Stage	(r.p.m.)	1492.00
PT nom. ratio		11 000/110
CT ratio 1 st stage		120/1
CT ratio 2 nd stage		250/1
Suction Dia.	(mm)	1000.00
Delivery 1st Stage Dia.	(mm)	800.00
Delivery 2nd Stage Dia.	(mm)	900.00
Total Operating Hours		64 982
Operating Hours Since Overhaul		11 870
Return to Service After Last Overhaul		July 2000
Operating Hours Since Previous Test	(Deg C)	11 754
Density	(kg/m^3)	997.296
Gravity	(m/sec^2)	9.785

ZUIKERBOSCH PUMP SET 23
SITE READINGS ON SUBSTANDARD INSTRUMENTS :-

		Acceptance Test June 1985					Annual Test February 2000					Ex Overhaul April 2003					Routine Test June 2007				
		TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5
Delivery valve position												1.00					1.00				
Voltage	(kV)						11.60	11.60	11.60	11.60	11.60	11.40	11.50	11.40	11.40	11.50	11.60	11.60	11.60	11.60	11.50
Frequency	(Hz)						50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Ammeter Readings 1st Stage	(A)	124.93	123.73	123.73	121.33	118.93	88.30	87.05	85.43	85.00	85.60	112.00	109.50	109.00	107.00	106.50	84.60	84.10	83.70	82.90	82.80
Ammeter Readings 2nd Stage	(A)	205.27	202.77	202.77	200.27	195.27	196.50	197.00	196.25	195.25	196.25	226.50	225.50	224.00	222.00	220.00	219.00	217.00	216.00	215.00	213.00
Energy Meter Stage 1	(kWh)	1427.05	1460.41	1401.09	1382.77	1332.75	293.35	288.95	283.91	279.54	281.81	304.51	301.20	298.09	293.84	144.71	281.35	279.74	277.08	273.79	274.42
Energy Meter Stage 2	(kWh)	3414.62	3398.17	3386.06	3352.37	3249.71	565.93	568.19	566.06	564.03	560.74	618.64	615.81	611.31	606.87	301.29	592.44	590.74	588.42	584.01	577.71
Time	(sec.)	299.83	300.01	300.06	600.05	299.81	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	300.00	600.00	600.00	600.00	600.00	600.00
Manometer Diff Head	(M/d)	262.830	235.830	223.500	206.540	159.000	278.909	241.273	211.182	203.454	191.455	284.560	253.333	232.720	208.110	185.105	248.872	231.781	214.349	199.804	172.488
Delivery Pressure 2nd Stage	(kPa)	1620.00	1725.00	1780.00	1825.00	1940.00	1612.67	1773.33	1897.33	1920.50	1940.67	1706.17	1840.20	1916.82	2004.29	2061.61	1782.49	1852.72	1919.26	1966.57	2041.47
Delivery Pressure 1st Stage	(kPa)	475.00	510.00	530.00	540.00	575.00	597.83	637.83	670.83	676.83	666.67	588.30	628.17	650.51	676.36	678.92	612.20	632.08	650.33	663.01	681.98
Suction Pressure	(kPa)	12.00	12.00	18.00	14.50	15.00	47.90	49.20	50.77	51.42	51.03	46.63	47.69	48.35	49.28	50.25	58.14	58.21	58.15	56.90	57.12
Speed 1st Stage	(r.p.m.)	692.00	692.00	692.00	692.00	692.00	743.00	744.00	743.00	744.00	743.00	744.50	743.00	743.00	743.00	743.00	744.00	745.00	744.00	744.00	744.00
Speed 2nd Stage	(r.p.m.)	1495.00	1495.00	1495.00	1495.00	1495.00	1493.50	1496.00	1495.00	1496.00	1496.00	1498.00	1495.00	1496.00	1495.00	1496.00	1497.00	1496.00	1497.00	1495.00	1497.00

CALCULATED RESULTS 1st & 2nd STAGE:

		TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5
Motor Current 1st Stage	(A)	124.93	123.73	123.73	121.33	118.93	88.30	87.05	85.43	85.00	85.60	112.00	109.50	109.00	107.00	106.50	84.60	84.10	83.70	82.90	82.80
Motor Current 2nd Stage	(A)	205.27	202.77	202.77	200.27	195.27	196.50	197.00	196.25	195.25	196.25	226.50	225.50	224.00	222.00	220.00	219.00	217.00	216.00	215.00	213.00
Stage kW 1st stage	(kW)	1427.05	1460.41	1401.09	1382.77	1332.75	1760.10	1733.70	1703.46	1677.24	1690.86	1827.06	1807.20	1788.54	1763.04	1736.52	1688.10	1678.44	1662.48	1642.74	1646.52
Stage kW 2nd stage	(kW)	3414.62	3398.17	3386.06	3352.37	3249.71	3395.58	3409.14	3396.36	3384.18	3364.44	3711.84	3694.86	3667.86	3641.22	3615.48	3554.64	3544.44	3530.52	3504.06	3466.26
Set kW	(kW)	4841.67	4858.58	4787.15	4735.14	4582.46	5155.68	5142.84	5099.82	5061.42	5055.30	5538.90	5502.06	5456.40	5404.26	5352.00	5242.74	5222.88	5193.00	5146.80	5112.78
Flow	(M/d)	222.915	211.155	205.561	197.608	173.381	229.633	213.578	199.816	196.126	190.255	231.947	218.851	209.758	198.358	187.073	216.916	209.335	201.309	194.359	180.585
Velocity Head 1st Stage	(m)	0.795	0.714	0.676	0.625	0.481	0.844	0.730	0.639	0.616	0.580	0.861	0.767	0.704	0.630	0.560	0.753	0.702	0.649	0.605	0.522
Generated Head 1st Stage	(m)	48.217	51.720	53.116	54.448	57.837	57.165	61.015	64.143	64.667	63.629	56.319	60.197	62.355	64.831	64.924	57.478	59.454	61.277	62.659	64.497
Velocity Head 2nd Stage	(m)	-0.506	-0.454	-0.430	-0.398	-0.306	-0.537	-0.465	-0.407	-0.392	-0.369	-0.548	-0.488	-0.448	-0.401	-0.357	-0.479	-0.446	-0.413	-0.385	-0.332
Generated Head 2nd Stage	(m)	116.767	123.989	127.597	131.215	139.500	103.396	115.826	125.204	126.977	130.107	113.900	123.601	129.198	135.554	141.205	119.336	124.525	129.502	133.075	138.854
Total Generated Head	(m)	164.984	175.708	180.713	185.662	197.337	160.561	176.841	189.347	191.644	193.736	170.218	183.797	191.552	200.385	206.129	176.814	183.979	190.779	195.734	203.350
Water kW 1st Stage	(kW)	1214.59	1234.10	1233.85	1215.84	1133.19	1483.52	1472.71	1448.46	1433.33	1368.10	1476.75	1489.32	1478.61	1453.78	1373.04	1409.48	1406.99	1394.53	1376.75	1316.70
Water kW 2nd Stage	(kW)	2941.40	2958.54	2963.98	2930.08	2733.18	2683.27	2795.70	2827.33	2814.41	2797.45	2986.61	3057.99	3063.66	3039.68	2986.26	2926.38	2946.89	2947.17	2923.92	2834.69
Water kW	(kW)	4155.99	4192.64	4197.83	4145.93	3866.37	4166.79	4268.41	4275.78	4247.75	4165.55	4463.37	4547.31	4542.27	4493.46	4359.30	4335.86	4353.88	4341.70	4300.68	4151.39
Efficiency 1st Stage	(%)	85.11	84.50	88.06	87.93	85.03	84.29	84.95	85.03	85.46	80.91	80.83	82.41	82.67	82.46	79.07	83.49	83.83	83.88	83.81	79.97
Efficiency 2nd Stage	(%)	86.14	87.06	87.53	87.40	84.11	79.02	82.01	83.25	83.16	83.15	80.46	82.76	83.53	83.48	82.60	82.33	83.14	83.48	83.44	81.78
Overall Efficiency	(%)	85.84	86.29	87.69	87.56	84.37	80.82	83.00	83.84	83.92	82.40	80.58	82.65	83.25	83.15	81.45	82.70	83.36	83.61	83.56	81.20

SUMMARISED TEST RESULTS FOR PUMP SET :-

Set kW	(kW)	4841.67	4858.58	4787.15	4735.14	4582.46	5155.68	5142.84	5099.82	5061.42	5055.30	5538.90	5502.06	5456.40	5404.26	5352.00	5242.74	5222.88	5193.00	5146.80	5112.78
Water kW	(kW)	4155.99	4192.64	4197.83	4145.93	3866.37	4166.79	4268.41	4275.78	4247.75	4165.55	4463.37	4547.31	4542.27	4493.46	4359.30	4335.86	4353.88	4341.70	4300.68	4151.39
Total Generated Head	(m)	164.98	175.71	180.71	185.66	197.34	160.56	176.84	189.35	191.64	193.74	170.22	183.80	191.55	200.39	206.13	176.81	183.98	190.78	195.73	203.35
Flow	(M/d)	222.92	211.16	205.56	197.61	173.38	229.63	213.58	199.82	196.13	190.25	231.95	218.85	209.76	198.36	187.07	216.92	209.33	201.31	194.36	180.59
Set Efficiency	(%)	85.84	86.29	87.69	87.56	84.37	80.82	83.00	83.84	83.92	82.40	80.58	82.65	83.25	83.15	81.45	82.70	83.36	83.61	83.56	81.20

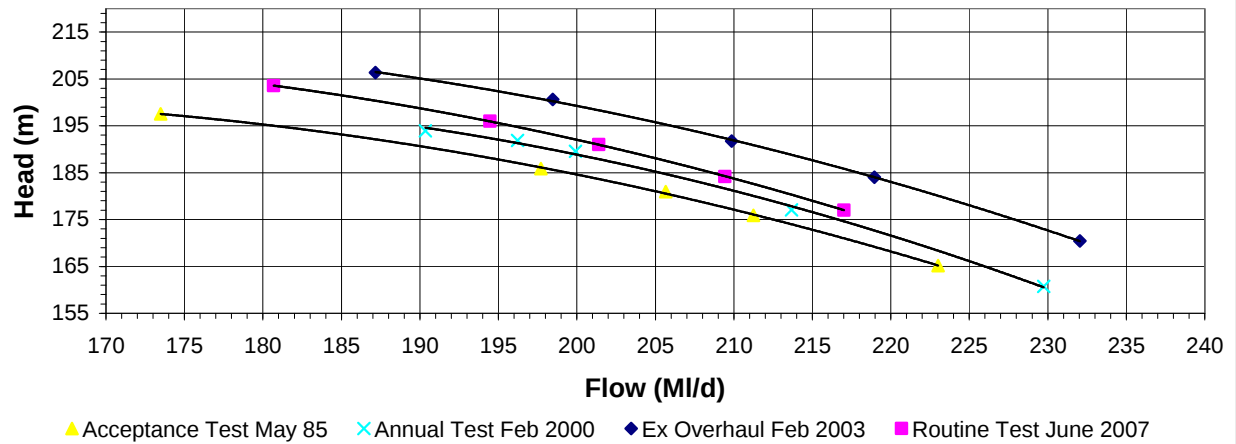
CALCULATED POWER AT DUTY POINT:-

Calculations are based on test with the flow rate nearest to duty point

Flow rate used:				197.61	M/d			199.82	M/d					198.36	M/d				201.31	M/d	
Efficiency at this point				87.56	%			83.84	%					83.15	%				83.61	%	
Power demand at duty point				4775.36	kW			4987.32	kW					5030.64	kW				5002.96	kW	
Percentage of guaranteed demand				100.22	%			104.67	%					105.58	%				105.00	%	

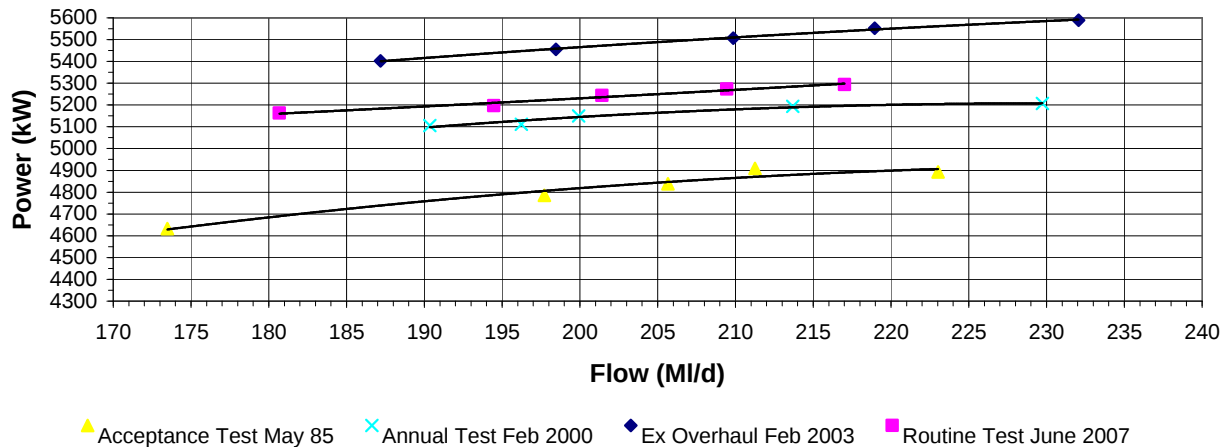
Q - H Curve (Set)

Zuikerbosch 23



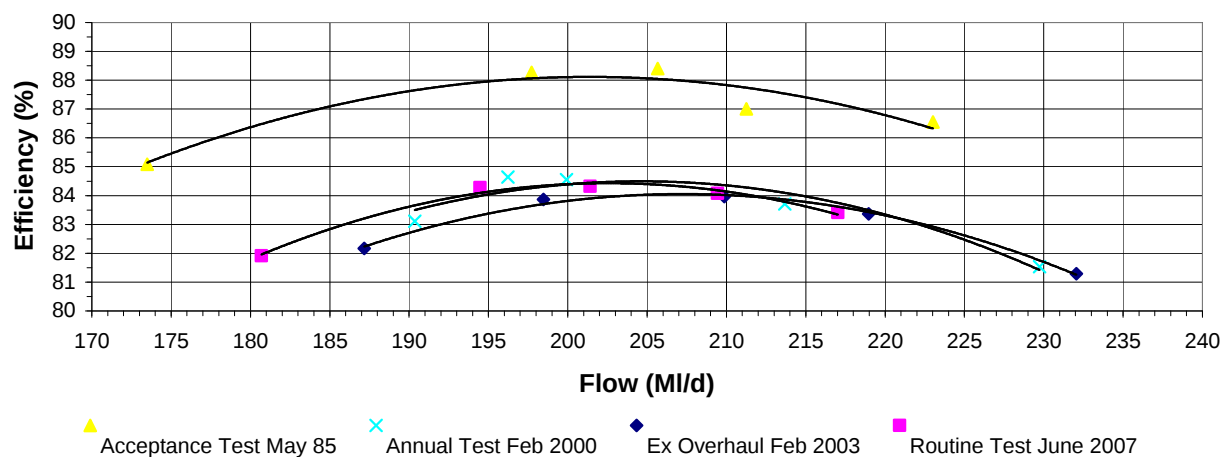
Q - kW Curve (Set)

Zuikerbosch 23



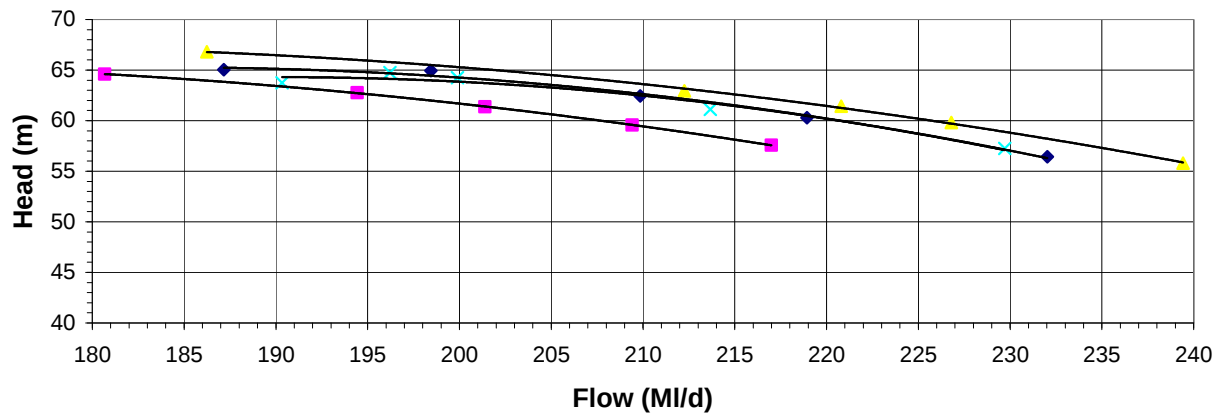
Q - Efficiency Curve (Set)

Zuikerbosch 23



Q - H Curve (St 1)

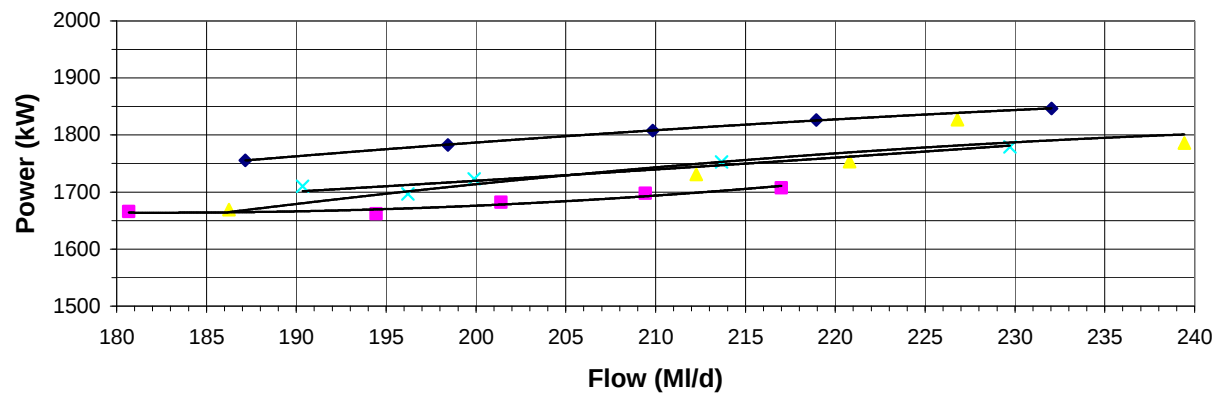
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▲ Acceptance Test May 85 ✕ Annual Test Feb 2000 ◆ Ex Overhaul Feb 2003 ■ Routine Test June 2007

Q - kW Curve (St 1)

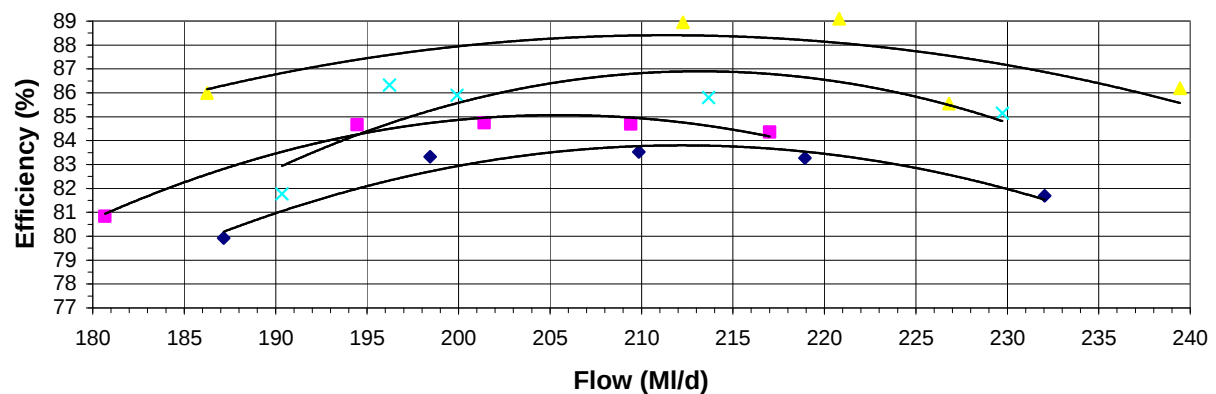
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▲ Acceptance Test May 85 ✕ Annual Test Feb 2000 ◆ Ex Overhaul Feb 2003 ■ Routine Test June 2007

Q - Efficiency Curve (St 1)

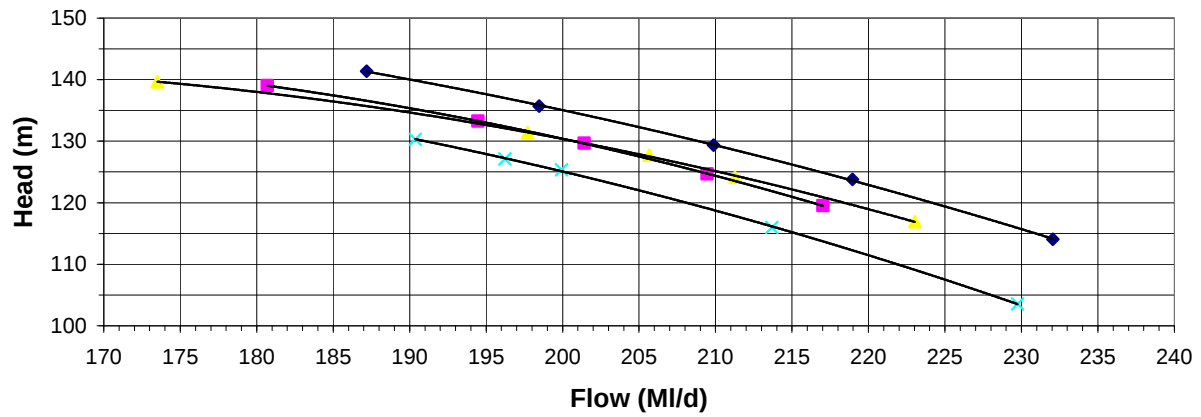
Zuikerbosch 23



▲ Acceptance Test May 85 ✕ Annual Test Feb 2000 ◆ Ex Overhaul Feb 2003 ■ Routine Test June 2007

Q - H Curve (St 2)

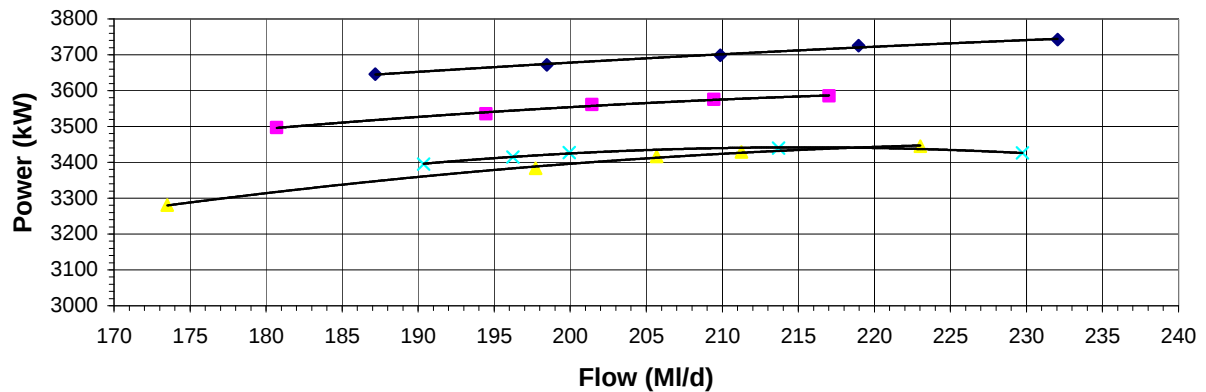
Zuikerbosch 23



▲ Acceptance Test May 85 × Annual Test Feb 2000 ◆ Ex Overhaul Feb 2003 ■ Routine Test June 2007

Q - kW Curve (St 2)

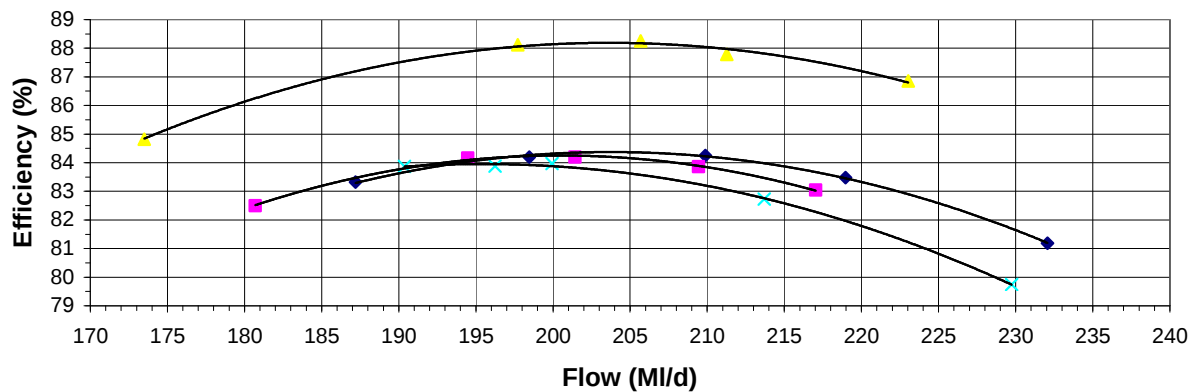
Zuikerbosch 23



▲ Acceptance Test May 85 × Annual Test Feb 2000 ◆ Ex Overhaul Feb 2003 ■ Routine Test June 2007

Q - Efficiency Curve (St 2)

Zuikerbosch 23



▲ Acceptance Test May 85 × Annual Test Feb 2000 ◆ Ex Overhaul Feb 2003 ■ Routine Test June 2007

See Distribution List

Quentin van der Berg

08 February 2000

Distribution List

General Manager Operations

Chief Engineer Operations

Chief Operations Engineer - Process

Chief Operations Engineer - Electrical

Chief Operations Engineer - Mechanical

Mechanical Engineer - Process

Planning Engineer

Manager - Zuikerbosch pumping station

Maintenance Engineer Area 2 - Zuikerbosch pumping station

Operations Engineer - Zuikerbosch pumping station

Planning Officer Area 2 - Zuikerbosch pumping station

ANNUAL TEST OF PUMP SET 23 IN ENGINE ROOM 4A AT ZUIKERBOSCH PUMPING STATION

This test was conducted to verify the condition of the pump set.

The following points were determined:

1. Generated head at duty flow rate.
2. Pump power demand at this flow.
3. Corresponding overall efficiency.
4. Overall vibration levels.

Results

The results of these tests are shown on the attached copies of the following:

1. Pump test data sheet indicating all flows, heads, powers and efficiencies of the pump set as well as calculations for power demand at duty point.
2. Characteristic curves for the pump set, namely:
 - a) Quantity - Head
 - b) Quantity - Power
 - c) Quantity -Efficiency
3. Overall vibration severity readings taken at duty point.

Comments

General

The first stage pump is driven by a 1705 kW variable speed motor. The variable speed facility was not operational when this pump set was tested on 01 February 2000. Two sets of pump characteristic curves are plotted for the first and second stage pumps. One set of curves indicates actual site conditions with the first stage motor operating at a speed of 744 Rpm. The second set of curves indicates values corrected for the first stage duty speed of 692 Rpm. This was done in order to compare the results of this test with the results of the acceptance test conducted during 1985.

During the test conducted on 01 February 2000 it was noted that the first stage pump Q-H characteristic curve is unstable¹ between the rate of flow of 190Ml/d and 195 Ml/d. This area of instability falls within the normal operating range of the pump set when the first stage pump is operated at 744 Rpm.

Performance

The efficiency of the first stage pump set has reduced by 2.90% to 85.03% when compared to the acceptance efficiency of 87.93%.

The efficiency of the second stage pump set has reduced by 4.15% to 83.25% when compared to the acceptance efficiency of 87.40%.

The overall efficiency of the pump set has reduced by 3.72% to 83.84% when compared to the acceptance efficiency of 87.56%.

Vibration

Vibration severity levels on both motors and pumps fall within the “satisfactory” region of I.S.O. Standard 2373 Class 3.

¹ Unstable in that the delivery pressure of the first stage pump decreases when the flow is decreased. The first stage pump becomes extremely noisy with fluctuating delivery pressure and flow.

Conclusion

- a. The pump set efficiency of pump set 23 is 0.72% and 1.18% lower than the pump set efficiency of pump sets 22 and 24 respectively.
- b. The economic viability study conducted on pump set 23 indicates that it is economically viable to overhaul this pump set. Provided that the efficiency of the pump set is restored to the acceptance efficiency, the net present value of the saving in electrical costs was calculated to be R 274 062.00.

The following criteria was used in the economic viability study:

- | | |
|---|-----------------|
| 1) Pump set utilisation: | 54.167% |
| 2) Saving in electrical costs during first month: | R 9 918 32 |
| 3) Period over which pump set efficiency deteriorated: (53 112 hrs) | 71 months |
| 4) Interest rate: | 13.5% per annum |

- c. During this test it was noticed that the first stage pump becomes unstable between a rate of flow of 185 Ml/d and 190 Ml/d when operating at a speed of 744 Rpm. The pump set should not be operated at this rate of flow as this could result in damage to the impellers.

Recommendations

- 1) It is recommended that pump set 23 be overhauled.
- 2) It is recommended that the design² of the first stage pump be investigated. The instability of the first stage pump in the region of 190 Ml/d when operating at 744 Rpm is undesirable.

**PUMP TEST TECHNICIAN
OPERATIONS (PROCESS)**

² Pump sets 22 and 23 at Zuikerbosch engine room 4A will no longer be utilized as variable speed pump sets.

Pump Set 23 Vibration Test

Stage :		1	2		
Speed (r.p.m.) :		743	1495		
Flow rate (Ml/d) :		200	200		
Vibration severity in mm/sec.					
	Pump	Ax	2.70	1.80	
		Nde v	2.70	1.75	
		H	2.40	4.30	
		De v	2.11	1.80	
		H	1.70	2.18	
	Motor	De v	1.67	0.42	
		H	1.01	1.57	
		Nde v	0.67	0.56	
		H	1.00	1.87	
		Ax	2.00	1.95	

I.S.O. Standard 2372 CLASS 3

Vibration severity in (mm/sec.)			
Good	0.00	to	1.80
Satisfactory	1.80	to	4.50
Needs Attention	4.50	to	11.00
Danger	11.00	+	

I.S.O. Standard 2372 CLASS 4

Vibration severity in (mm/sec.)			
Good	0.00	to	2.80
Satisfactory	2.80	to	7.00
Needs Attention	7.00	to	18.00
Danger	18.00	+	

R A N D W A T E R

PUMP TEST REPORT

Station:	Zuikerbosch
Engineroom:	4A
Pumps tested:	Pump set No 23
Date of test:	1 February 2000
Observer:	Q. van der Berg

DETAILS ARE AS FOLLOWS :-

Contract Number		1387
Pump Manufacturer		MATHER & PLATT
Type of pump (Stage 1)		SDS DV 800/1000
Serial Number (Stage 1)		Not available
Motor Manufacturer (Stage 1)		ASEA
Serial Number (Stage 1)		7250-289
Rated Voltage (Stage 1 and 2)	(kV)	11000
Rated Power	(kW)	1705
Rated Amps	(A)	109
Type of pump (Stage 2)		SDS DV 700/800
Serial Number (Stage 2)		Not available
Motor Manufacturer (Stage 2)		BBC
Serial Number (Stage 2)		ZSM-0139
Rated Power	(kW)	3850
Rated Amps	(A)	235
Duty Flow Rate	(Ml/d)	200.00
Flow Meter Constant		13.7500
Duty Generated Head (Set)	(m)	185.00
Guaranteed Demand (set)	(kW)	4764.68
Guaranteed Efficiency	(%)	87.87
Duty Speed 1st Stage	(r.p.m.)	692.00
Duty Speed 2nd Stage	(r.p.m.)	1492.00
PT nom. ratio		100.00
CT ratio 1 st stage		120.00
CT ratio 2 nd stage		250.00
Suction Dia.	(mm)	1000.00
Delivery 1st Stage Dia.	(mm)	800.00
Delivery 2nd Stage Dia.	(mm)	900.00
Running Hours		53112.00
Water Temperature	(Deg C)	21.50
Density	(kg/m ³)	997.296
Gravity	(m/sec ²)	9.79

PUMP SET 23

SITE READINGS ON SUBSTANDARD INSTRUMENTS :-

		Acceptance Test June 1985					Annual Test February 2000				
		TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5
Delivery valve position											
Voltage	(kV)						11.60	11.60	11.60	11.60	11.60
Frequency	(Hz)	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Ammeter Readings 1st Stage	(A)	124.93	123.73	123.73	121.33	118.93	88.30	87.05	85.43	85.00	85.60
Ammeter Readings 2nd Stage	(A)	205.27	202.77	202.77	200.27	195.27	196.50	197.00	196.25	195.25	196.25
Energy Meter Stage 1	(kWh)	1427.05	1460.41	1401.09	1382.77	1332.75	293.35	288.95	283.91	279.54	281.81
Energy Meter Stage 2	(kWh)	3414.62	3398.17	3386.06	3352.37	3249.71	565.93	568.19	566.06	564.03	560.74
Time	(sec.)	299.83	300.01	300.06	600.05	299.81	600.00	600.00	600.00	600.00	600.00
Manometer Diff Head	(MI/d)	262.830	235.830	223.500	206.540	159.000	278.909	241.273	211.182	203.454	191.455
Delivery Pressure 2nd Stage	(kPa)	1620.00	1725.00	1780.00	1825.00	1940.00	1612.67	1773.33	1897.33	1920.50	1940.67
Delivery Pressure 1st Stage	(kPa)	475.00	510.00	530.00	540.00	575.00	597.83	637.83	670.83	676.83	666.67
Suction Pressure	(kPa)	12.00	12.00	18.00	14.50	15.00	47.90	49.20	50.77	51.42	51.03
Speed 1st Stage	(r.p.m.)	692.00	692.00	692.00	692.00	692.00	743.00	744.00	743.00	744.00	743.00
Speed 2nd Stage	(r.p.m.)	1495.00	1495.00	1495.00	1495.00	1495.00	1493.50	1496.00	1495.00	1496.00	1496.00

CALCULATED RESULTS 1st & 2nd STAGE:

		TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5
Motor Current 1st Stage	(A)	124.93	123.73	123.73	121.33	118.93	88.30	87.05	85.43	85.00	85.60
Motor Current 2nd Stage	(A)	205.27	202.77	202.77	200.27	195.27	196.50	197.00	196.25	195.25	196.25
Stage kW 1st stage	(kW)	1427.05	1460.41	1401.09	1382.77	1332.75	1760.10	1733.70	1703.46	1677.24	1690.86
Stage kW 2nd stage	(kW)	3414.62	3398.17	3386.06	3352.37	3249.71	3395.58	3409.14	3396.36	3384.18	3364.44
Set kW	(kW)	4841.67	4858.58	4787.15	4735.14	4582.46	5155.68	5142.84	5099.82	5061.42	5055.30
Flow	(MI/d)	222.915	211.155	205.561	197.608	173.381	229.633	213.578	199.816	196.126	190.255
Velocity Head 1st Stage	(m)	0.795	0.714	0.676	0.625	0.481	0.844	0.730	0.639	0.616	0.580
Generated Head 1st Stage	(m)	48.217	51.720	53.116	54.448	57.837	57.165	61.015	64.143	64.667	63.629
Velocity Head 2nd Stage	(m)	-0.506	-0.454	-0.430	-0.398	-0.306	-0.537	-0.465	-0.407	-0.392	-0.369
Generated Head 2nd Stage	(m)	116.767	123.989	127.597	131.215	139.500	103.396	115.826	125.204	126.977	130.107
Total Generated Head	(m)	164.984	175.708	180.713	185.662	197.337	160.561	176.841	189.347	191.644	193.736
Water kW 1st Stage	(kW)	1214.59	1234.10	1233.85	1215.84	1133.19	1483.52	1472.71	1448.46	1433.33	1368.10
Water kW 2nd Stage	(kW)	2941.40	2958.54	2963.98	2930.08	2733.18	2683.27	2795.70	2827.33	2814.41	2797.45
Water kW	(kW)	4155.99	4192.64	4197.83	4145.93	3866.37	4166.79	4268.41	4275.78	4247.75	4165.55
Efficiency 1st Stage	(%)	85.11	84.50	88.06	87.93	85.03	84.29	84.95	85.03	85.46	80.91
Efficiency 2nd Stage	(%)	86.14	87.06	87.53	87.40	84.11	79.02	82.01	83.25	83.16	83.15
Overall Efficiency	(%)	85.84	86.29	87.69	87.56	84.37	80.82	83.00	83.84	83.92	82.40

SUMMARISED TEST RESULTS FOR PUMP SET :-

Set kW	(kW)	4841.67	4858.58	4787.15	4735.14	4582.46	5155.68	5142.84	5099.82	5061.42	5055.30
Water kW	(kW)	4155.99	4192.64	4197.83	4145.93	3866.37	4166.79	4268.41	4275.78	4247.75	4165.55
Total Generated Head	(m)	164.98	175.71	180.71	185.66	197.34	160.56	176.84	189.35	191.64	193.74
Flow	(MI/d)	222.92	211.16	205.56	197.61	173.38	229.63	213.58	199.82	196.13	190.25
Set Efficiency	(%)	85.84	86.29	87.69	87.56	84.37	80.82	83.00	83.84	83.92	82.40

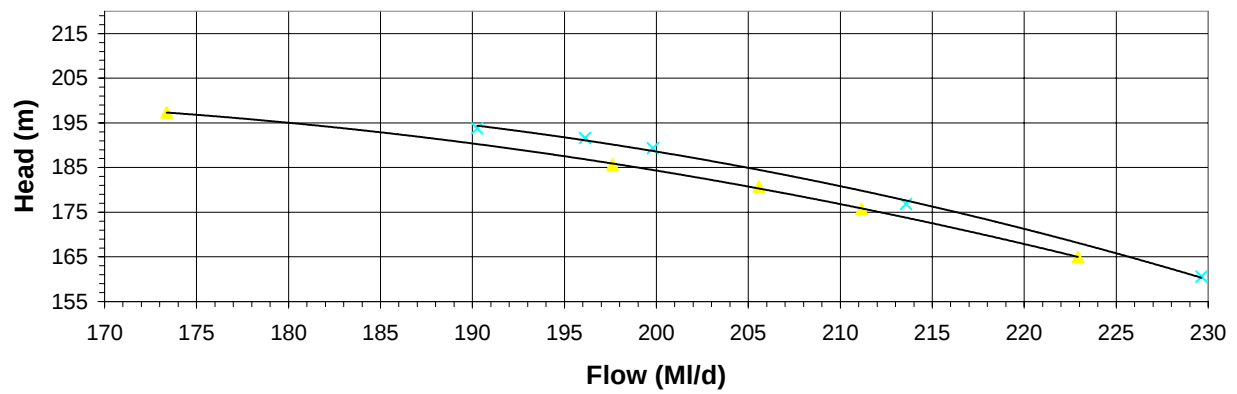
CALCULATED POWER AT DUTY POINT:-

Calculations are based on test with the flow rate nearest to duty point

Flow rate used:		197.61	MI/d	199.82	MI/d
Efficiency at this point		87.56	%	83.84	%
Power demand at duty point		4775.36	kW	4987.32	kW
Percentage of guaranteed demand		100.22	%	104.67	%

Q - H Curve (Set)

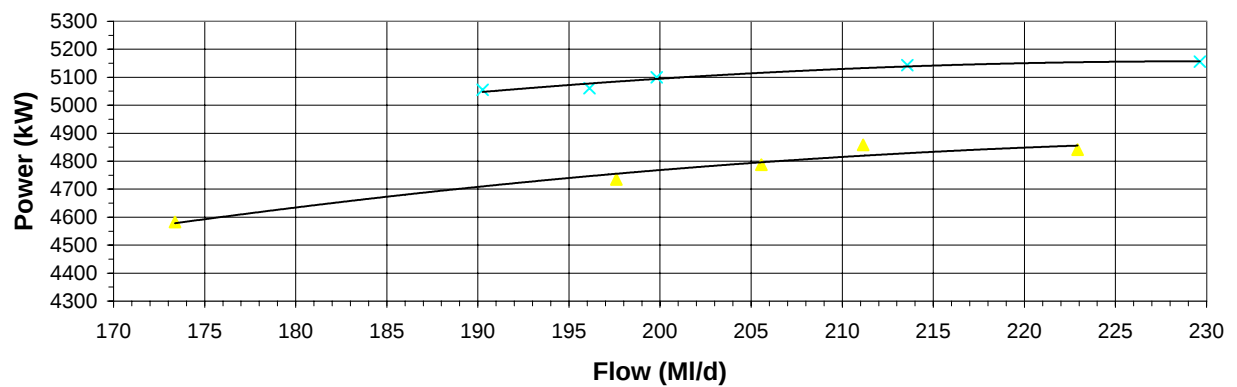
Zuikerbosch 23



▲ Acceptance Test May 85 ✕ Annual Test Feb 2000

Q - kW Curve (Set)

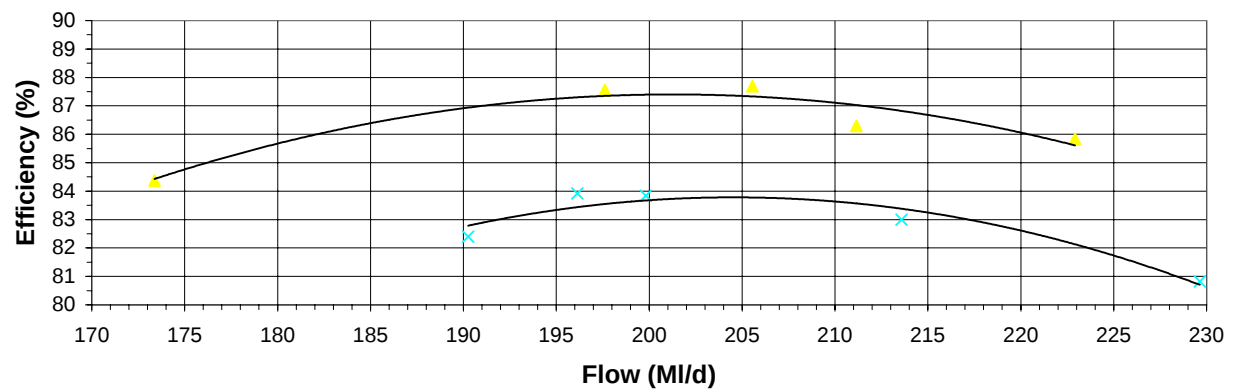
Zuikerbosch 23



▲ Acceptance Test May 85 ✕ Annual Test Feb 2000

Q - % Curve (Set)

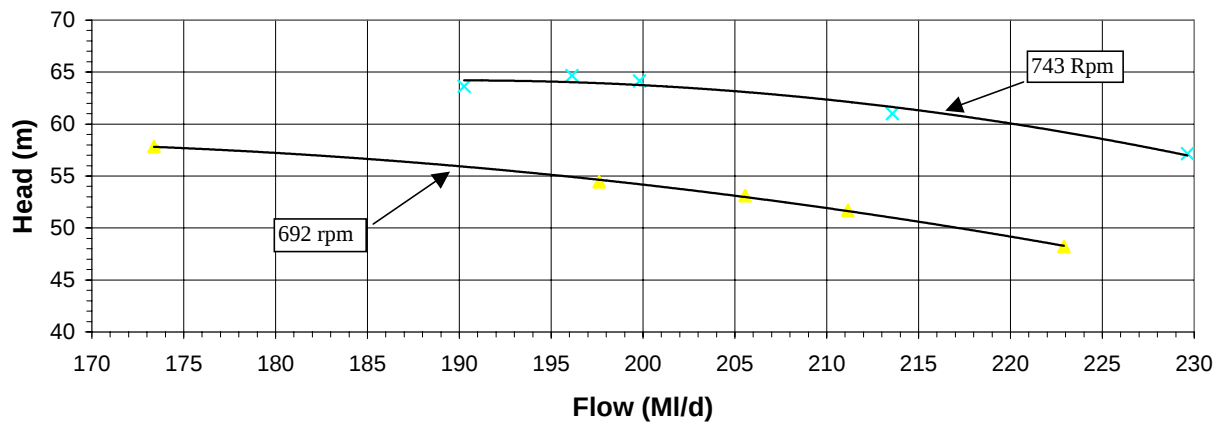
Zuikerbosch 23



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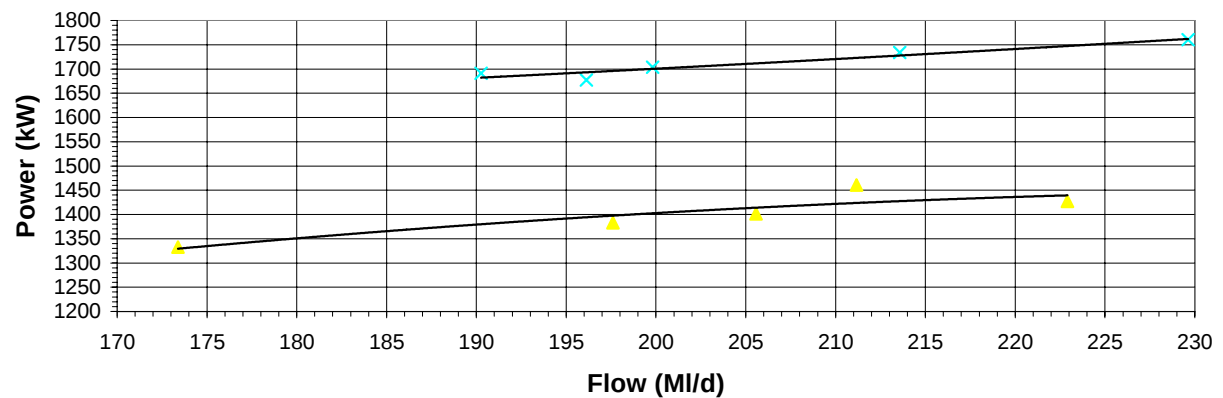
Q - H Curve (St 1)

Zuikerbosch 23



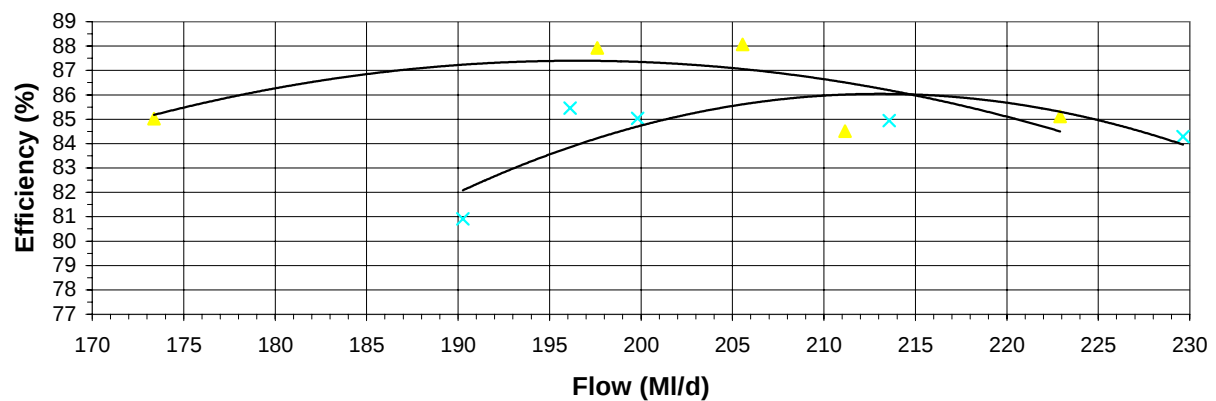
Q - kW Curve (St 1)

Zuikerbosch 23



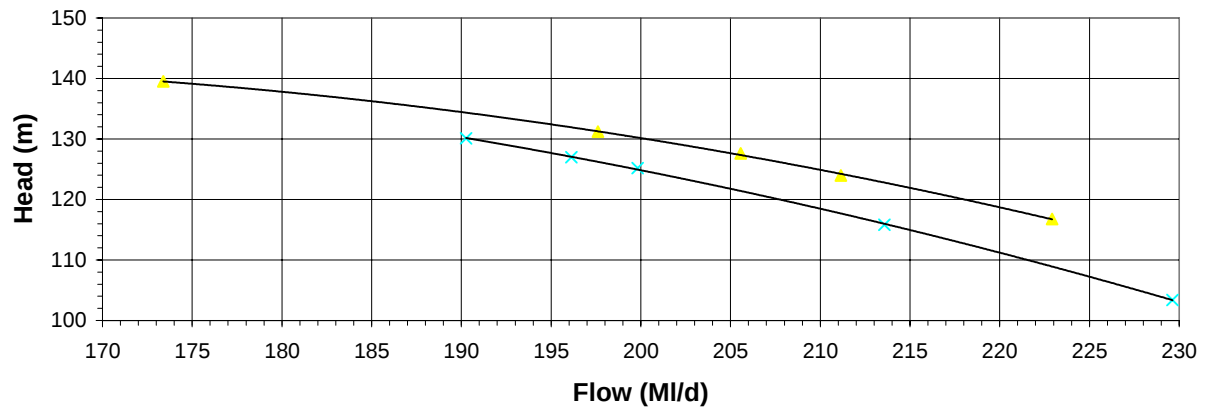
Q - % Curve (St 1)

Zuikerbosch 23



Q - H Curve (St 2)

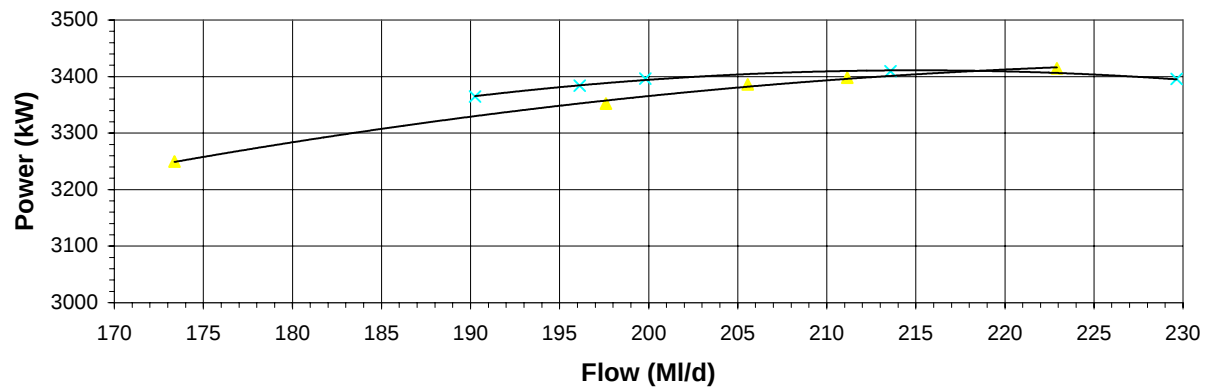
Zuikerbosch 23



▲ Acceptance Test May 85 × Annual Test Feb 2000

Q - kW Curve (St 2)

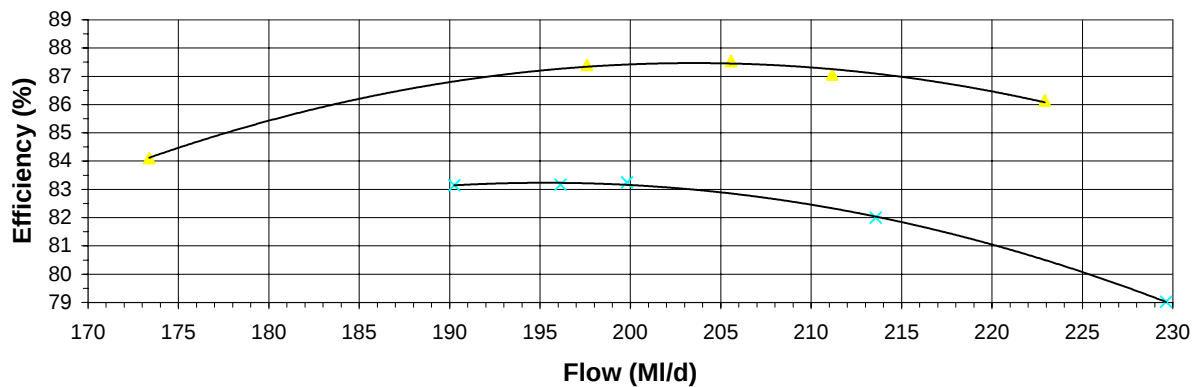
Zuikerbosch 23



▲ Acceptance Test May 85 × Annual Test Feb 2000

Q - % Curve (St 2)

Zuikerbosch 23



▲ Acceptance Test May 85 × Annual Test Feb 2000

PUMP SET 23
SITE READINGS ON SUBSTANDARD INSTRUMENTS :-

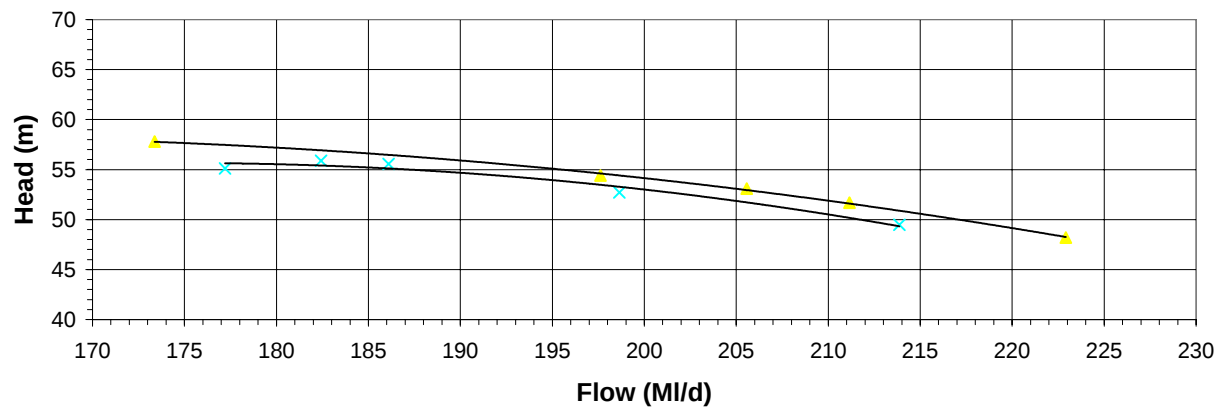
		Acceptance Test June 1985					Annual Test February 2000				
		TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5
Delivery valve position											
Frequency	(Hz)	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Ammeter Readings 1st Stage	(A)	124.93	123.73	123.73	121.33	118.93	88.30	87.05	85.43	85.00	85.60
Ammeter Readings 2nd Stage	(A)	205.27	202.77	202.77	200.27	195.27	196.50	197.00	196.25	195.25	196.25
Energy Meter Stage 1	(kWh)	1427.05	1460.41	1401.09	1382.77	1332.75	1760.10	1733.70	1703.46	1677.24	1690.86
Energy Meter Stage 2	(kWh)	3414.62	3398.17	3386.06	3352.37	3249.71	3395.58	3409.14	3396.36	3384.18	3364.44
Time	(sec.)	299.83	300.01	300.06	600.05	299.81	600.00	600.00	600.00	600.00	600.00
Manometer Diff Head	(M/d)	262.830	235.830	223.500	206.540	159.000	278.909	241.273	211.182	203.454	191.455
Delivery Pressure 2nd Stage	(kPa)	1620.00	1725.00	1780.00	1825.00	1940.00	1612.67	1773.33	1897.33	1920.50	1940.67
Delivery Pressure 1st Stage	(kPa)	475.00	510.00	530.00	540.00	575.00	597.83	637.83	670.83	676.83	666.67
Suction Pressure	(kPa)	12.00	12.00	18.00	14.50	15.00	47.90	49.20	50.77	51.42	51.03
Speed 1st Stage	(r.p.m.)	692.00	692.00	692.00	692.00	692.00	743.00	744.00	743.00	744.00	743.00
Speed 2nd Stage	(r.p.m.)	1495.00	1495.00	1495.00	1495.00	1495.00	1493.50	1496.00	1495.00	1496.00	1496.00

CALCULATED RESULTS 1st & 2nd STAGE CORRECTED TO DUTY SPEED:

		TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5
Motor Current 1st Stage	(A)	124.93	123.73	123.73	121.33	118.93	88.30	87.05	85.43	85.00	85.60
Motor Current 2nd Stage	(A)	205.27	202.77	202.77	200.27	195.27	196.50	197.00	196.25	195.25	196.25
Stage kW 1st stage	(kW)	1427.05	1460.41	1401.09	1382.77	1332.75	1421.97	1395.00	1376.21	1349.57	1366.03
Stage kW 2nd stage	(kW)	3394.10	3377.75	3365.72	3332.23	3230.19	3385.36	3381.87	3375.95	3357.11	3337.52
Set kW	(kW)	4821.15	4838.16	4766.81	4715.00	4562.94	4807.33	4776.86	4752.16	4706.67	4703.55
Flow Stage 1	(M/d)	222.915	211.155	205.561	197.608	173.381	213.871	198.651	186.101	182.419	177.196
Flow Stage 2	(M/d)	222.468	210.732	205.149	197.212	173.033	229.402	213.007	199.415	195.602	189.746
Velocity Head 1st Stage	(m)	0.795	0.714	0.676	0.625	0.481	0.732	0.632	0.555	0.533	0.503
Generated Head 1st Stage	(m)	48.189	51.690	53.085	54.416	57.804	49.490	52.699	55.566	55.872	55.127
Velocity Head 2nd Stage	(m)	-0.504	-0.452	-0.429	-0.396	-0.305	-0.536	-0.462	-0.405	-0.390	-0.367
Generated Head 2nd Stage	(m)	116.232	123.420	127.012	130.613	138.860	103.189	115.210	124.704	126.301	129.414
Total Generated Head	(m)	164.421	175.110	180.098	185.029	196.664	152.679	167.909	180.270	182.173	184.541
Water kW 1st Stage	(kW)	1214.60	1234.11	1233.86	1215.85	1133.20	1196.17	1183.08	1168.65	1151.83	1103.94
Water kW 2nd Stage	(kW)	2923.77	2940.80	2946.21	2912.51	2716.78	2675.22	2773.39	2810.38	2791.94	2775.11
Water kW	(kW)	4138.37	4174.91	4180.07	4128.36	3849.98	3871.39	3956.47	3979.02	3943.77	3879.05
Efficiency 1st Stage	(%)	85.11	84.50	88.06	87.93	85.03	84.12	84.81	84.92	85.35	80.81
Efficiency 2nd Stage	(%)	86.14	87.06	87.54	87.40	84.11	79.02	82.01	83.25	83.17	83.15
Overall Efficiency	(%)	85.84	86.29	87.69	87.56	84.37	80.53	82.83	83.73	83.79	82.47

Q - H Curve (St 1) Corrected for speed

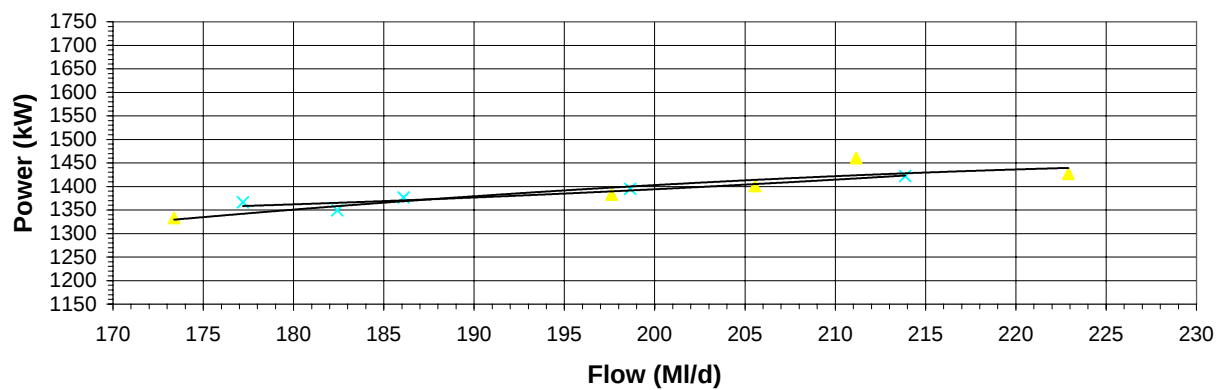
Zuikerbosch 23



▲ Acceptance Test June 85 ✕ Annual Test Feb 2000

Q - kW Curve (St 1)

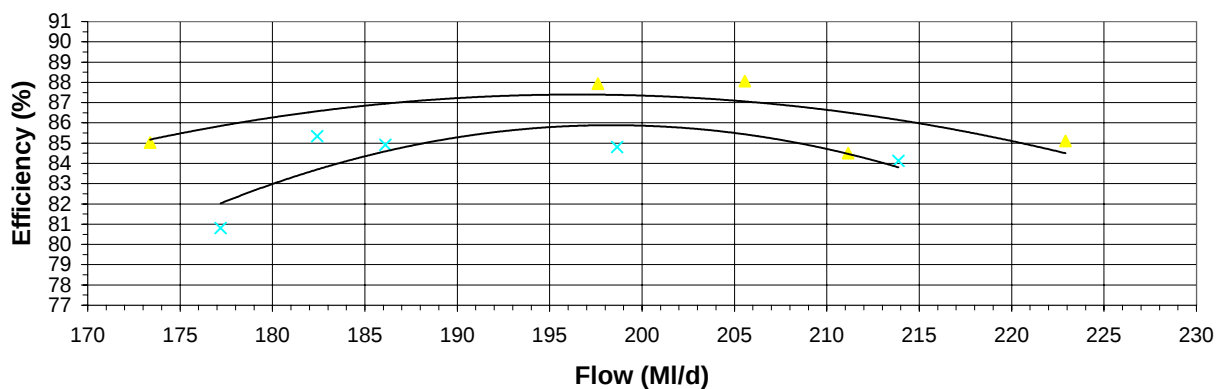
Zuikerbosch 23



▲ Acceptance Test June 2000 ✕ Annual Test Feb 2000

Q - % Curve (St 1)

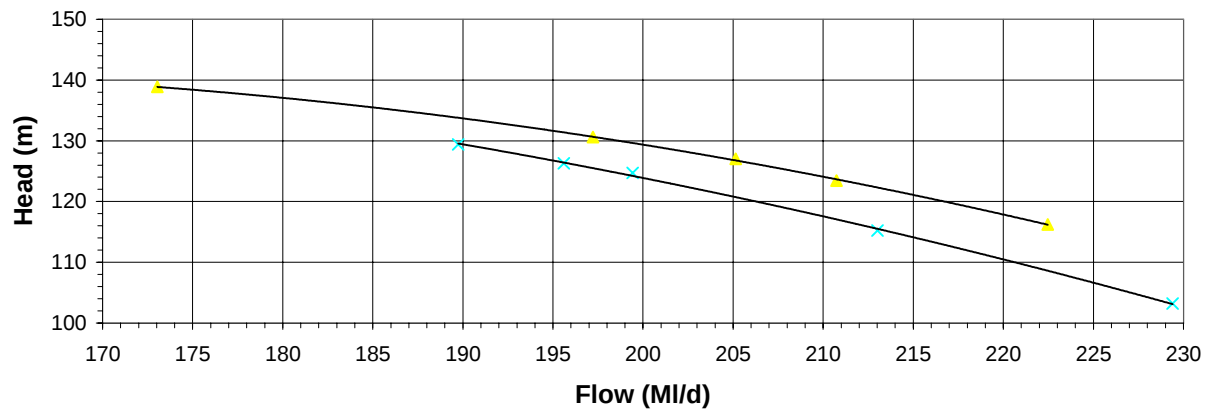
Zuikerbosch 23



▲ Acceptance Test June 2000 ✕ Annual Test Feb 2000

Q - H Curve (St 2) Corrected for speed

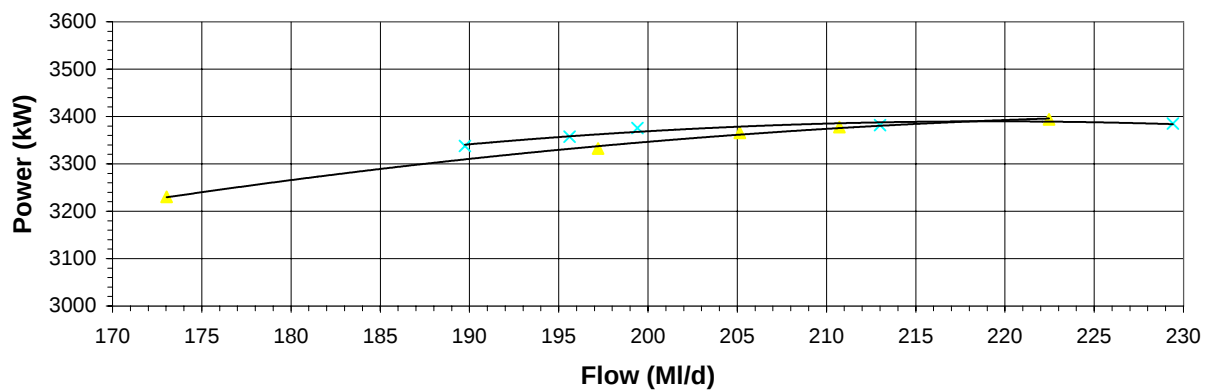
Zuikerbosch 23



▲ Acceptance Test June 2000 × Annual Test Feb 2000

Q - kW Curve (St 2)

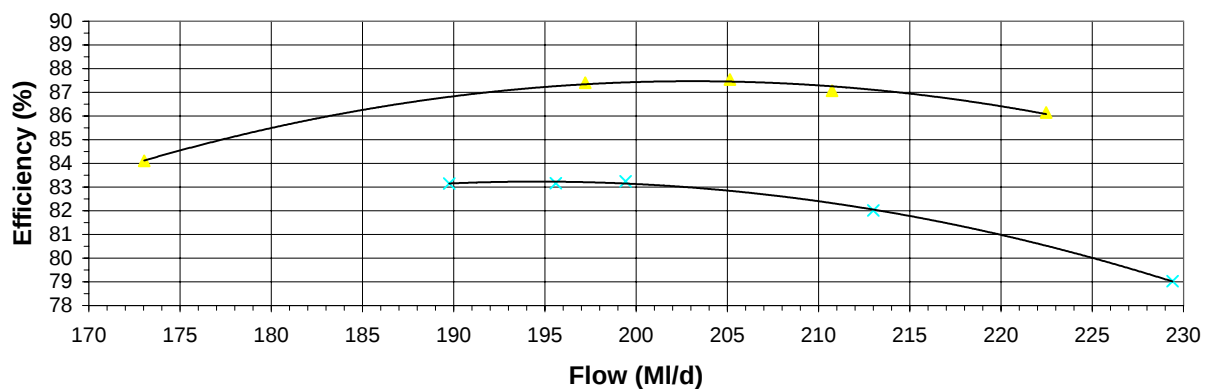
Zuikerbosch 23



▲ Acceptance Test June 2000 × Annual Test Feb 2000

Q - % Curve (St 2)

Zuikerbosch 23



▲ Acceptance Test June 85 × Annual Test Feb 2000