

May 2020

PERFORMANCE TEST RESULTS FOR FANS INSTALLED ON KUKEN COOLING TOWERS AT VIVOCITY

By



Block 194 Pandan Loop
#06-09 Pantech Complex
Singapore 128383

1.0 INTRODUCTION

The conventional KUKEN cooling tower fans and motors in VivoCity were replaced with energy efficient H’FLO fans with optimized blade profiles and high efficiency motors as part of an energy efficiency improvement project.

Measurements were carried out before and after the fans & motors were replaced to verify the performance of the new fans and this report summarises the measured data and findings.

2.0 KUKEN AND H’FLO FAN PERFORMANCE TESTS

2.1 Specification of fans

The specification of the original KUKEN and new H’FLO fans are given below.

Parameter / Manufacturer	KUKEN	H’FLO
Material	Pultruded Fibre-reinforced plastic (FRP)	Fibre-reinforced plastic (FRP)
Fan diameter (mm)	2000	2000
Hub diameter (mm)	500	750
Traverse area (m ²)	3.27	3.02
Ring / Stack diameter (mm)	2100	2100
Blade angle (°)	NA	26 (Cooling towers 1-5) 16 (Cooling towers 6-7)
Rated motor power (kW)	7.5	7.5

2.2 Pre and post-performance data

The performance, in terms of airflow and power, of the conventional KUKEN cooling tower fans prior to removal and the new H’FLO fans after installation were measured for each cooling tower and the results are tabulated below. The airflow and power were measured at 50 Hz for pre and post measurements and an additional post measurement was also conducted at 44 Hz for H’FLO fan blades. The results of each of the 7 cooling towers are shown below.

2.2.1 Cooling tower CT-1 airflow and power data

Cooling tower	Airflow (m ³ /s) using KUKEN fan blades (pre-measurement)	Airflow (m ³ /s) using H’FLO fan blades (post-measurement) @50 Hz	Airflow (m ³ /s) using H’FLO fan blades (post-measurement) @44 Hz	Power consumption (kW) using KUKEN fan blades (pre-measurement)	Power consumption (kW) using H’FLO fan blades (post-measurement) @44 Hz	Power savings (%)
CT1-1	35.64	36.75	35.18	7.30	5.40	26
CT1-2	35.59	36.59	35.96	7.30	5.40	26
CT1-3	33.03	37.78	33.01	7.30	5.40	26
CT1-4	31.76	35.87	32.42	7.30	5.30	27
CT1-5	32.44	35.01	33.47	7.30	5.40	26
CT1-6	30.01	35.51	31.94	7.30	5.40	26
CT1-7	30.80	35.80	31.52	7.30	5.40	26
CT1-8	31.77	35.73	32.18	7.30	5.40	26
Average	32.62	36.13	33.21	7.30	5.39	26

On average, a clear increase in airflow of roughly 11% is observed for the cooling tower after fan blade replacement when comparing airflow rate data at 50 Hz.

Similarly, since airflow rate of KUKEN fan blades at 50 Hz is comparable to airflow rate of H’FLO fan blades at 44 Hz, a power saving of nearly 26% is observed.

2.2.2 Cooling tower CT-2 airflow and power data

Cooling tower	Airflow (m ³ /s) using KUKEN fan blades (pre-measurement)	Airflow (m ³ /s) using H'FLO fan blades (post-measurement) @50 Hz	Airflow (m ³ /s) using H'FLO fan blades (post-measurement) @44 Hz	Power consumption (kW) using KUKEN fan blades (pre-measurement)	Power consumption (kW) using H'FLO fan blades (post-measurement) @44 Hz	Power savings (%)
CT2-1	32.55	35.48	32.79	7.30	5.30	27
CT2-2	32.83	36.51	32.80	7.30	5.40	26
CT2-3	32.61	36.05	32.46	7.30	5.30	27
CT2-4	32.36	37.03	32.61	7.30	5.30	27
CT2-5	32.06	37.37	32.41	7.30	5.40	26
CT2-6	32.75	37.28	32.64	7.30	5.30	27
CT2-7	32.54	37.23	32.77	7.30	5.40	26
CT2-8	32.19	35.52	32.01	7.30	5.40	26
Average	32.49	36.56	32.56	7.30	5.35	26.5

On average, a clear increase in airflow of roughly 12.5% is observed for the cooling tower after fan blade replacement when comparing airflow rate data at 50 Hz.

Similarly, since airflow rate of KUKEN fan blades at 50 Hz is comparable to airflow rate of H'FLO fan blades at 44 Hz, a power savings of nearly 26.5% is observed.

2.2.3 Cooling tower CT-3 airflow and power data

Cooling tower	Airflow (m ³ /s) using KUKEN fan blades (pre-measurement)	Airflow (m ³ /s) using H'FLO fan blades (post-measurement) @50 Hz	Airflow (m ³ /s) using H'FLO fan blades (post-measurement) @44 Hz	Power consumption (kW) using KUKEN fan blades (pre-measurement)	Power consumption (kW) using H'FLO fan blades (post-measurement) @44 Hz	Power savings (%)
CT3-1	32.36	36.14	32.24	7.30	5.40	27
CT3-2	32.27	36.10	32.20	7.30	5.40	27
CT3-3	32.36	36.05	32.16	7.30	5.30	26
CT3-4	32.47	36.00	32.11	7.30	5.30	26
CT3-5	32.46	36.11	32.21	7.30	5.40	27
CT3-6	21.33	36.14	32.24	7.30	5.40	27
CT3-7	32.17	35.95	32.07	7.30	5.40	27
CT3-8	32.22	35.89	32.02	7.30	5.30	26
Average	30.96	36.05	32.16	7.30	5.36	27

On average, a clear increase in airflow of roughly 16% is observed for the cooling tower after fan blade replacement when comparing airflow rate data at 50 Hz.

Similarly, since airflow rate of KUKEN fan blades at 50 Hz is comparable to airflow rate of H'FLO fan blades at 44 Hz, a power savings of nearly 27% is observed.

2.2.4 Cooling tower CT-4 airflow and power data

Cooling tower	Airflow (m ³ /s) using KUKEN fan blades (pre-measurement)	Airflow (m ³ /s) using H'FLO fan blades (post-measurement) @50 Hz	Airflow (m ³ /s) using H'FLO fan blades (post-measurement) @44 Hz	Power consumption (kW) using KUKEN fan blades (pre-measurement)	Power consumption (kW) using H'FLO fan blades (post-measurement) @44 Hz	Power savings (%)
CT4-1	34.45	38.47	34.44	7.30	5.40	26
CT4-2	33.73	37.61	33.68	7.30	5.30	27
CT4-3	33.50	39.14	33.30	7.30	5.30	27
CT4-4	34.25	38.36	34.36	7.30	5.40	26
CT4-5	33.96	36.32	34.13	7.30	5.40	26
CT4-6	33.64	38.39	33.68	7.30	5.30	27
CT4-7	34.43	35.74	34.24	7.30	5.40	26
CT4-8	34.09	38.72	34.05	7.30	5.40	26
Average	34.01	37.84	33.98	7.30	5.36	26.5

On average, a clear increase in airflow of roughly 11% is observed for the cooling tower after fan blade replacement when comparing airflow rate data at 50 Hz.

Similarly, since airflow rate of KUKEN fan blades at 50 Hz is comparable to airflow rate of H'FLO fan blades at 44 Hz, a power savings of nearly 26.5% is observed.

2.2.5 Cooling tower CT-5 airflow and power data

Cooling tower	Airflow (m ³ /s) using KUKEN fan blades (pre-measurement)	Airflow (m ³ /s) using H'FLO fan blades (post-measurement) @50 Hz	Airflow (m ³ /s) using H'FLO fan blades (post-measurement) @44 Hz	Power consumption (kW) using KUKEN fan blades (pre-measurement)	Power consumption (kW) using H'FLO fan blades (post-measurement) @44 Hz	Power savings (%)
CT5-1	33.45	37.58	33.18	7.20	5.30	26
CT5-2	34.20	38.19	33.99	7.20	5.30	26
CT5-3	33.39	40.31	33.30	7.30	5.30	27
CT5-4	33.34	38.89	33.42	7.30	5.40	26
CT5-5	32.93	36.49	33.50	7.20	5.20	27
CT5-6	33.28	38.08	33.36	7.20	5.20	27
CT5-7	33.36	38.61	33.30	7.10	5.10	28
CT5-8	33.45	37.58	33.18	7.10	5.10	28
Average	33.34	38.24	33.40	7.20	5.20	27

On average, a clear increase in airflow of roughly 15% is observed for the cooling tower after fan blade replacement when comparing airflow rate data at 50 Hz.

Similarly, since airflow rate of KUKEN fan blades at 50 Hz is comparable to airflow rate of H'FLO fan blades at 44 Hz, a power savings of nearly 27% is observed.

2.2.6 Cooling tower CT-6 airflow and power data

Cooling tower	Airflow (m ³ /s) using KUKEN fan blades (pre-measurement)	Airflow (m ³ /s) using H'FLO fan blades (post-measurement) @50 Hz	Airflow (m ³ /s) using H'FLO fan blades (post-measurement) @44 Hz	Power consumption (kW) using KUKEN fan blades (pre-measurement)	Power consumption (kW) using H'FLO fan blades (post-measurement) @44 Hz	Power savings (%)
CT6-1	33.66	38.09	33.50	7.40	5.40	27
CT6-2	33.21	37.59	33.05	7.30	5.30	27
CT6-3	33.12	37.60	32.99	7.30	5.30	27
CT6-4	33.27	37.80	33.11	7.40	5.40	27
Average	33.31	37.77	33.16	7.35	5.35	27

On average, a clear increase in airflow of roughly 14% is observed for the cooling tower after fan blade replacement when comparing airflow rate data at 50 Hz.

Similarly, since airflow rate of KUKEN fan blades at 50 Hz is comparable to airflow rate of H'FLO fan blades at 44 Hz, a power savings of nearly 27% is observed.

2.2.7 Cooling tower CT-7 airflow and power data

Cooling tower	Airflow (m ³ /s) using H'FLO fan blades @50 Hz	Airflow (m ³ /s) using H'FLO fan blades @44 Hz	Increase in airflow (%)	Power consumption (kW) using H'FLO fan blades @50 Hz	Power consumption (kW) using H'FLO fan blades @44 Hz	Power savings (%)
CT7-1	38.04	33.95	12	7.40	5.40	27
CT7-2	38.67	34.10	13	7.50	5.40	28
CT7-3	38.27	34.10	12	7.40	5.40	27
CT7-4	38.09	33.95	12	7.40	5.40	27
Average	38.27	34.02	12	7.40	5.40	27

On average, an increase in air flow of roughly 12% is observed for the cooling tower fans when operating at 50 Hz as compared to 44 Hz.

Similarly, if airflow rate at 44 Hz is sufficient, operating the cooling tower fans at 44 Hz yields an average power saving of roughly 27%.

3.0 CONCLUSION

Based on the data presented above, it is clear that there is both an increase in airflow and decrease in power consumption at same airflow rates after the original KUKEN cooling tower fan blades and motors were replaced with H'FLO fan blades and motors. Therefore, it can be concluded that the H'FLO fan blades and motors have met the project objectives.