

Determination of service standard time for liquid waste parameter in certification institution

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Abstract. Baristand Industry Medan is a technical implementation unit under the Industrial and Research and Development Agency, the Ministry of Industry. One of the services often used in Baristand Industry Medan is liquid waste testing service. The company set the standard of service 9 working days for testing services. At 2015, 89.66% on testing services liquid waste does not meet the specified standard of services company. The purpose of this research is to specify the standard time of each parameter in testing services liquid waste. The method used is the stopwatch time study. There are 45 test parameters in liquid waste laboratory. The measurement of the time done 4 samples per test parameters using the stopwatch. From the measurement results obtained standard time that the standard Minimum Service test of liquid waste is 13 working days if there is testing E. coli.

1. Introduction

Baristand Industry Medan is a technical implementation unit under the Industrial and Research and Development Agency, the Ministry of Industry. One of the services often used in Baristand Industry Medan is liquid waste testing service.

The testing is the determination of one or more of the characteristics of an object the assessment according to the procedure. The procedure itself is a way to implement an activity or process. The testing is usually applied to the ingredients, products or process according to the procedure. Meanwhile, laboratory is the place of scientific research, experiments or measurements scientific training done. Service activities and laboratory testing in general is to meet the standardization, where all types of ingredients, products and the process is in accordance with certain standards that are assigned to maintain the quality a product/service in the community/consumers. Liquid Waste is a joint or a mixture of water and pollutants carried by the good in the situation dissolved and dispersed suspended domestic (offices, housing and trade), the source of industry and on a specific time mixed with the ground water surface water or rain water.

Baristand Industry Medan specify the standard services for at least 9 working days for testing services. Working days in Baristand Medan is Monday to Friday. 2015, 89.66% on testing services liquid waste does not meet the specified standard of company. The cause of not achieving the minimum standard of services is the old testing time. Testing time is determined by how many test parameters that will be tested in accordance with the customer request. There are 45 effluent testing parameters that can be tested in Baristand Medan Industry that consists of 8 test parameters the nature of physics, 22 test parameters chemical nature, 12 test parameters of metal and 3 parameters a microbiology test. To know how long time testing each parameter, will be done measurement standard



time. The measurement of the time is done 4 samples per test parameters, because the capacity of the laboratory only can test 4 sample daily.

2. Research Method

a. The measurement of the time.

The measurement of the working time (Time Study) was an attempt to determine the length of time the work that is required by an operator to complete a work. The measurement of the time consists of 2 types, namely the measurement of the time directly and the measurement of time indirectly [1]. The measurement of the time that is done in this research is the measurement of the time directly using the stopwatch.

b. Testing the uniformity of the data

A data said uniform if all of the data between the two border controls, namely the limit of control over and the under-control limit. the formulation of the limit of control over and under control limit is as follows [1]

c. Testing the adequacy of the data

The adequacy of the data is done to get whether the amount of data observation result enough to do research. To count the number of measurement is required for the level of carefulness 5 percent and the level of confidence 95% is as follows [5]:

When $N' \leq N$, then the amount of data is enough

When $N' > N$, then the amount of data is not enough

d. Rating Factor and Allowance

Rating factor is a technique to equate the result of observation of the operator in completing a work with the time required by the normal operator in completing the job. According to [2] rating factor (P) has three limitations, namely:

$p > 1$ when the operator work too fast

$p < 1$ when the operator working under normal (too slowly)

$p = 1$ when the operator to work normal

There are many methods used to determine rating factors. The following is some method in determining the rating factor that generally used [1]:

1. The Method Skill and Effort Rating
2. The Method Westinghouse
3. The Method Synthetic Rating
4. Performance Rating or Speed Rating
5. The Method Objective

The giving of the allowance is intended to provide the opportunity for the operator to do the things that must be done so that the raw material is obtained can be said the complete working time data and represent the working system that is observed. The concession is given among others:

1. Allowance for personal needs
2. Allowance to eliminate fatigue (fatigue)
3. Allowance to the things that could not be avoided

e. The cycle times.

The cycle times is the time required to create one product unit on a single workstation [3]. The time required to implement the elements of the typical work element- will differ slightly from the cycle to other cycle, even if the operator is working at normal speed or uniform, each of the elements in a different cycle does not always will be completed in the same time.

f. The Normal time.

The normal time for a working operating element is shows that a good qualified operator will work completed the work on the tempo work normal [1].

g. The Standard Time.

The determination of the time standard for each parameter test is done with the way the measurement directly using the stopwatch. Standard Time is obtained by multiplying the normal time with allowance[4].

3. The results

Testing the liquid waste consists of 5 operators. Each operator to test different parameters, division test parameters based on the operator is divided into:

1. The Operator A can test for smell parameters, BOD, conductivity, turbidity, dissolved oxygen (O₂), slurries dissolved, pH, taste, temperature, Total Solid Suspension (TSS), colors and organic substances.
2. The Operator B can test for fluoride parameters (F), oil/fat, NH₃-N, nitrate, nitric, nitrogen total, phosphate, cyanide and sulfide.
3. The Operator C can test alkalinity parameters, COD, calcium, hardness, chloride, magnesium, salinity, silica, mercury, arsenic, iron, cadmium, chrome, cobalt, potassium, manganese, nickel, zinc, copper, and lead.
4. The Operator D can test for total coliform parameters, E. coli, and numbers total fins.
5. The Operator E can test for boron parameters.

Testing cycle time consisted of several activities namely:

1. Preparing the equipment and the chemicals for the testing process.
2. Testing process. On this testing process for each different test parameters. The activities on this testing process consists of weigh the chemical, make the solution, add some ml solution, do titration, do distillation, heat sample, create calibration curve and read the examples on spectrophotometer test.
3. Perform the calculation of the test results and record the test results.
For example, activities test parameters smell.

Table 1. The Cycle Times to Smell Test Parameters

Activities	The Measurement of The Time (Minutes)									
	1	2	3	4	5	6	7	8	9	10
Took the beaker glass.	0.30	0.30	0.40	0.35	0.30	0.40	0.30	0.30	0.30	0.30
Pour test example into the beaker glass.	2.50	2.40	2.38	2.20	2.25	2.57	2.60	2.50	2.10	2.50
Scent.	0.50	0.55	0.60	0.45	0.63	0.50	0.50	0.40	0.43	0.50
Record results.	0.57	0.50	0.60	0.50	0.57	0.57	0.57	0.60	0.42	0.51
Total Time (minutes)	3.87	3.75	3.98	3.50	3.75	4.04	3.97	3.90	3.25	3.81

Test the uniformity of data for smell parameter and the average time measurements smell is:

$$\bar{x} = \frac{\sum x_i}{N} \quad (1)$$

$$\bar{x} = \frac{3,87+3,75+3,98+3,50+3,75+4,04+3,97+3,90+3,25+3,81}{10} = 3,782 \quad (2)$$

The Standard deviation of time measurement smell parameter is :

$$\sigma = \sqrt{\frac{\sum (x_i - \bar{x})^2}{N-1}} \quad (3)$$

$$\sigma = \sqrt{\frac{0,527}{10-1}} = 0,242 \quad (4)$$

The calculation of the value of control over (BKA), the limit under control (BKB) is:

$$BKA = \bar{x} + 2\sigma = 3,782 + 2(0,242) = 4,266 \quad (5)$$

$$BKB = \bar{x} - 2\sigma = 3,782 - 2(0,242) = 3,298 \quad (6)$$

Map control test uniformity odor data can be seen in Figure 1.

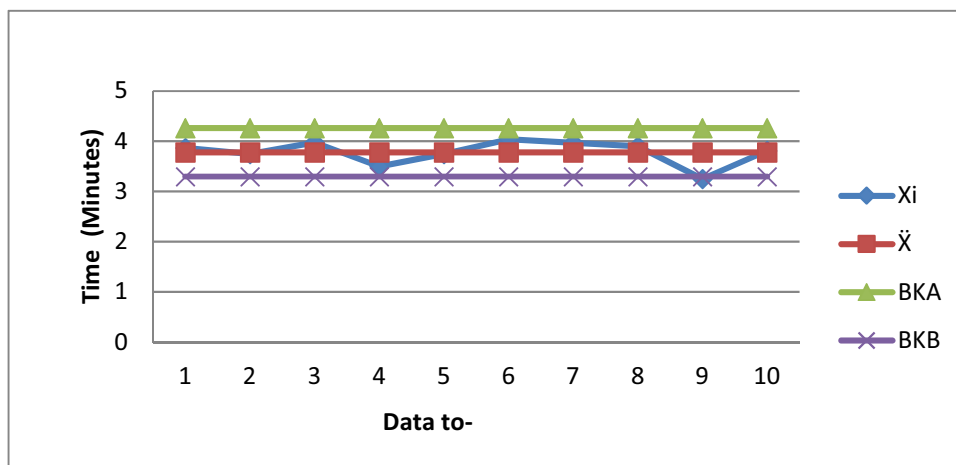


Figure 1. Control Map Test Data Uniformity Smell

Test the adequacy data is done to see whether the data taken from the observation was sufficient for use. In this research, the level of confidence that is used is 95% then k is 2, and high precision used is 5%, then the value of s is 0.05. Calculation formula N' is as follows:

$$N' = \left\lceil \frac{k/s \sqrt{N \sum x_i^2 - (\sum x_i)^2}}{\sum x_i} \right\rceil \quad (7)$$

If the value of $N' < N$ then enough data, and if $N' > N$ then the data is not enough. For example, test the adequacy data smell parameter:

$$N' = \left\lceil \frac{k/s \sqrt{N \sum x_i^2 - (\sum x_i)^2}}{\sum x_i} \right\rceil$$

$$N' = \left\lceil \frac{2/0,05 \sqrt{(10 \times 143,563) - 37,820^2}}{37,820} \right\rceil = 5,908$$

The value of $N' = 5,908 < N$ worth 10, then observations are enough to smell test parameters. The recapitulation of the uniformity test data and test the adequacy of the data for the measurement of all test parameters can be seen in the Table 2.

Table 2. Recapitulation Of Uniformity Tests And Test The Adequacy Of Data

The Operator	Test Parameters	Test the uniformity of data.			Description	Test adequacy of data		
		Average	BKA	BKB		N ^r	N	Description
A	Smell	3.782	4.266	3.298	Uniform	5.908	10	Enough
	BOD	5371.650	5487.383	5255.917	Uniform	0.149	5	Enough
	Conductivity	10.924	11.724	10.124	Uniform	1.930	10	Enough
	Turbidity	40.367	42.359	38.375	Uniform	0.876	10	Enough
	Dissolved Oxygen	31.706	34.152	29.260	Uniform	2.041	7	Enough
	Slurries Dissolves	22.184	24.807	19.561	Uniform	4.474	5	Enough
	pH	36.313	40.313	32.313	Uniform	4.367	10	Enough
	Taste	3.344	3.846	2.842	Uniform	8.119	10	Enough
	Temperature	9.573	10.294	8.852	Uniform	1.891	6	Enough
	Total Solid Suspension (TSS)	850.360	929.255	771.465	Uniform	3.099	10	Enough
B	Color	33.873	36.761	30.984	Uniform	2.181	4	Enough
	Organic Substances	36.948	40.488	33.407	Uniform	3.213	8	Enough
	Fluoride (F)	104.890	109.837	99.943	Uniform	0.712	5	Enough
	Oil and Fat	1622.963	1645.762	1600.164	Uniform	0.068	7	Enough
	NH3-N	273.453	292.928	253.977	Uniform	1.522	4	Enough
	Nitrate (NO3)	228.563	231.422	225.704	Uniform	0.042	3	Enough
	Nitric (NO2)	76.054	78.766	73.342	Uniform	0.407	5	Enough
	Nitrogen Total	859.238	885.643	832.834	Uniform	0.315	6	Enough
	Phosphate (PO4)	114.963	121.306	108.620	Uniform	0.812	3	Enough
	Cyanide (CN)	197.808	209.394	186.223	Uniform	1.143	6	Enough
C	Sulfate (SO4)	101.205	107.182	95.228	Uniform	1.046	4	Enough
	Alkalinity	40.778	44.659	36.896	Uniform	2.718	4	Enough
	COD	178.137	199.334	156.940	Uniform	5.097	10	Enough
	Calcium (Ca)	91.240	98.881	83.599	Uniform	2.244	5	Enough
	Hardness	27.786	30.016	25.556	Uniform	2.061	5	Enough
	Chloride (Cl)	30.240	32.584	27.896	Uniform	1.922	5	Enough
	Magnesium (Mg)	89.410	92.079	86.741	Uniform	0.238	3	Enough
	Salinity	42.747	45.926	39.567	Uniform	1.475	3	Enough
	Silica (SiO2)	430.347	432.281	428.413	Uniform	0.005	3	Enough
	Mercury (Hg)	142.427	145.972	138.881	Uniform	0.165	3	Enough
D	Arsan (As)	147.354	154.263	140.445	Uniform	0.704	5	Enough
	Iron (Fe)	135.893	140.699	131.088	Uniform	0.333	3	Enough
	Cadmium (Cd)	138.106	144.889	131.323	Uniform	0.844	8	Enough
	Chrome I	126.300	132.220	120.380	Uniform	0.659	4	Enough
	Cobalt (Co)	143.237	150.502	135.972	Uniform	0.686	3	Enough
	Potassium (K)	132.778	142.304	123.252	Uniform	1.647	5	Enough
	Mangan (Mn)	136.608	142.745	130.472	Uniform	0.673	6	Enough
	Nickel (Ni)	127.836	137.564	118.108	Uniform	1.853	5	Enough
	Zinc(Zn)	128.837	135.088	122.586	Uniform	0.807	7	Enough
	Copper (Cu)	134.909	141.592	128.225	Uniform	0.841	7	Enough
E	Lead (Pb)	134.745	142.016	127.474	Uniform	1.019	8	Enough
	Total Coliform	4558.853	4720.732	4396.973	Uniform	0.378	4	Enough
	E.coli	17064.550	17193.260	16935.840	Uniform	0.015	3	Enough
E	Number Total Fins	2275.870	2315.589	2236.151	Uniform	0.081	3	Enough
	Boron	88.137	89.418	86.855	Uniform	0.056	3	Enough

The formula to find the normal time:

$$Wn = Ws \times p \quad (8)$$

Where:

W_n = the normal Time

W_s = cycle times

p = adjustment factor, if $p = 1$ working fair, $p < 1$ working too slowly and $p > 1$ working too fast.

The formula to find standard time:

$$W_b = W_n \times (1 + All) \quad (9)$$

Where:

W_b = Time raw material/standard

W_n = the normal Time

All = Allowance

Recapitulation Result of standard time for all test parameters can be seen in Table 3.

Table 3. Recapitulation of Standard Time

The Operator	Test Parameter	Cycle Time (minutes)	p	Normal Time (minutes)	(1+All)	Standard Time (minutes)
A	Smell	3.782	1	3.78	1.11	4.20
	BOD	5371.650	1	5371.65	1.11	5962.53
	Conductivity	10.924	1	10.92	1.11	12.13
	Turbidity	40.367	1	40.37	1.11	44.81
	Dissolved Oxygen	31.706	1	31.71	1.11	35.19
	Slurries Dissolves	22.184	1	22.18	1.11	24.62
	pH	36.313	1	36.31	1.11	40.31
	Taste	3.344	1	3.34	1.11	3.71
	Temperature	9.573	1	9.57	1.11	10.63
	Total Solid Dud pension (TSS)	850.360	1	850.36	1.11	943.90
B	Color	33.873	1	33.87	1.11	37.60
	Organic Substances	36.948	1	36.95	1.11	41.01
	Fluoride (F)	104.890	1	104.89	1.13	118.53
	Oil and Fat	1622.963	1	1622.96	1.13	1833.95
	NH ₃ -N	273.453	1	273.45	1.13	309.00
	Nitrate (NO ₃)	228.563	1	228.56	1.13	258.28
	Nitric (NO ₂)	76.054	1	76.05	1.13	85.94
	Nitrogen Total	859.238	1	859.24	1.13	970.94
	Phosphate (PO ₄)	114.963	1	114.96	1.13	129.91
	Cyanide (CN)	197.808	1	197.81	1.13	223.52
C	Sulfate (SO ₄)	101.205	1	101.21	1.13	114.36
	Alkalinity	40.778	1	40.78	1.31	53.42
	COD	178.137	1	178.14	1.31	233.36
	Calcium (Ca)	91.240	1	91.24	1.31	119.52
	Hardness	27.786	1	27.79	1.31	36.40
	Chloride (Cl)	30.240	1	30.24	1.31	39.61
	Magnesium (Mg)	89.410	1	89.41	1.31	117.13
	Salinity	42.747	1	42.75	1.31	56.00
	Silica (SiO ₂)	430.347	1	430.35	1.31	563.75
	Mercury (Hg)	142.427	1	142.43	1.31	186.58
	Arsan (As)	147.354	1	147.35	1.31	193.03
	Iron (Fe)	135.893	1	135.89	1.31	178.02
	Cadmium (Cd)	138.106	1	138.11	1.31	180.92
	Chrome I	126.300	1	126.30	1.31	165.45
	Cobalt (Co)	143.237	1	143.24	1.31	187.64

	Potassium (K)	132.778	1	132.78	1.31	173.94
	Mangan (Mn)	136.608	1	136.61	1.31	178.96
	Nickel (Ni)	127.836	1	127.84	1.31	167.47
	Zinc(Zn)	128.837	1	128.84	1.31	168.78
	Copper (Cu)	134.909	1	134.91	1.31	176.73
	Lead (Pb)	134.745	1	134.75	1.31	176.52
	Total Coliform	4558.853	1	4558.85	1.11	5060.33
D	E.coli	17064.550	1	17064.55	1.11	18941.65
	Number Total Fins	2275.870	1	2275.87	1.11	2526.22
E	Boron	88.137	1	88.14	1.11	97.83

4. Conclusion

Test parameters that have the largest time is E. coli namely 18941,65 minutes = 315,69 hours = 13 days, so if the customer wants to test E. Coli then the minimum standard of services testing of liquid waste is 13 days, if there is no testing of e. coli, minimum standard of services remain 9 days.

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