Test Project

Task B3 – Jar test

Water Technology

Submitted by:

Thomas Schwab - ADIRO Automatisierungstechnik Gmb, Independent Test Project Designer
Liu Qishan - Singapore Polytechnic, Independent Test Project Designer

Hamza Lekhbizi - H+E GmbH, Independent Test Project Validator

Contents

Introduction **3**
Description of project and tasks **3**
Instructions to the Competitor **3**
Jar Test Procedure 3
Optimum coagulant dosage *3*
Mixing adequacy on flocculation *3*
Optimum flocculant dosage *3*
Colour and Turbidity Measurement 4
Calculations 4
Data and Report **8**
Marking Scheme **11**

© WorldSkills International

Introduction

Jar test is a laboratory test that simulates coagulation and flocculation with different chemical doses to determine the right amount of chemicals for water/wastewater treatment. This task requires competitors to perform Jar Test (coagulation, flocculation and sedimentation analysis) to determine the optimum coagulant and flocculant dosage. The mixing adequacy on flocculation will also be evaluated.

Description of project and tasks

Your task:

1. Collect water from raw water tank for Jar Test.
2. Prepare and perform Jar Test using at least 6 beakers to find out optimum coagulant, mixing adequacy on flocculation, and flocculant dosage respectively.
3. Document your results.
4. Determine the optimum coagulant, mixing adequacy, and flocculant dosages to achieve good water quality.

Lab coat, gloves and safety glasses are required for this task.

Instructions to the Competitor

Jar Test Procedure

Optimum coagulant dosage

1. Collect raw water and fill each of the six beakers with 1 liter of water.
2. Calibrate pH meter and measure the pH of raw water.
3. Place the prepared beakers under the stirrers.
4. Add appropriate quantity of coagulant solution (alum, or ferric sulphate) to the six beakers and perform pH level adjustment after addition of coagulant while mixing, e.g., adjusting pH level to around 8.5. The typical pH range is 7.0 – 9.5 for better coagulation during jar test.
5. Follow the operation procedure of Jar Tester to run the device with an appropriate speed for rapid mixing for about 1 min, then with a slow mixing for about 20 mins for flocculation to occur.
6. Turn off the device and allow settling for at least 15 mins in the beakers.
7. Collect an appropriate quantity of supernatant from each beaker for water quality measurement by following instrument procedure, e.g., colour and turbidity measurement.
8. Complete the required calculation and determine optimum coagulant dosage.

Mixing adequacy on flocculation

1. Repeat the above steps with varied mixing, e.g., 5 – 100 rpm, to the six beakers with the addition of the optimum coagulant concentration determined earlier.
2. Complete the required calculation and determine mixing adequacy.

Optimum flocculant dosage

1. Repeat the steps with varied amount of flocculants to the six beakers with the addition of the optimum coagulant concentration and appropriate mixing determined above to find out the optimum flocculant dosage.

© WorldSkills International

2. Complete the required calculation and determine optimum flocculant dosage.

Colour and Turbidity Measurement

1. Follow instructions of instrument manufacturers, measure and record colour and turbidity of the water samples.

Calculations

Chemical concentration (C) calculation:

$$C = \frac{V \text{ x } d \text{ x } c\% \text{ x } 1000}{Vrw}$$

C: chemical concentration in mg/L

V: volume of chemicals added to water in mL

d: density of chemicals added to the water in g/mL

c%: percentage of chemicals added to water

V_{rw}: volume of raw water in L

Removal efficiency (R):

$$R = \frac{(I - F)}{I} \text{x} 100$$

R: removal efficiency (%)

I: initial value of water quality, e.g., color or turbidity (raw water)

F: final value of water quality, e.g., color or turbidity (water after jar test)

© WorldSkills International

Table 1. Density of chemical solution at standard 20°C and 1 atm conditions.

CHEMICAL SOLUTION	CONCENTRATION	DENSITY (G/ML)
Sodium hydroxide (NaOH)	2%, or 0.5 M	1.02
Sodium hydroxide (NaOH)	5%, or 1.25 M	1.03
Sodium hydroxide (NaOH)	10%, or 2.5 M	1.11
Calcium hydroxide ($Ca(OH)_2$)	10%, 1.35 M	1.09
Hydrochloric acid (HCl)	1.823%, or 0.5 M	1.01
Hydrochloric acid (HCl)	3.646%, or 1.0 M	1.02
Aluminum sulphate ($Al_2(SO_4)_3$)	15%	1.07
Aluminum sulphate ($Al_2(SO_4)_3$)	20%	1.12
Iron (III) chloride ($FeCl_3$)	1%	1.08
Iron (III) chloride ($FeCl_3$)	5%	1.10
Iron (III) chloride ($FeCl_3$)	35%	1.38

Note: density of chemical solutions under 1% in concentration should be considered equal to water density.

© WorldSkills International

To continue.

© WorldSkills International

Tables, Graphs and Pictures

B3 – Jar Test

© WorldSkills International

Data and Report

Country Name: _____ **Competitor Name:** _____

Table 2: Jat test data on optimum coagulant dosage.

DESCRIPTION	ITEM\JAR NO	RAW WATER	1	2	3	4	5	6
pH Adjustment	pH							
	Volume of alkali added (ml)	--						
	-- Concentration (mg/L)	--						
	Volume of acid added (ml)	--						
	-- Concentration (mg/L)	--						
	pH (after adjustment)	--						
Coagulant Dose	Volume of coagulant added (ml)	--						
	-- Concentration (mg/L)	--						
Clarifying Water Quality	Colour							
	Colour removal (%)	--						
	Turbidity (NTU)							
	Turbidity removal (%)	--						

Table 3: Optimal dosage of coagulant.

NAME	JAR NUMBER
Jar number (beaker with the best clarified water quality):	

© WorldSkills International

Table 4: Jat test data of mixing adequacy on flocculation.

DESCRIPTION	ITEM\JAR NO	RAW WATER	1	2	3	4	5	6
pH Adjustment	pH							
	Volume of alkali added (ml)	--						
	-- Concentration (mg/L)	--						
	Volume of acid added (ml)	--						
	-- Concentration (mg/L)	--						
	pH (after adjustment)	--						
	Mixing strength (rpm)							
Mixing Adequacy	Velocity gradient (G) value (s^{-1})							
	Camp number*							
	Is mixing satisfactory? (Yes/No) Note: for satisfactory flocculation, Camp number should be in range of 10,000 – 100,000.							
	Temperature (°C) of water							
Clarifying Water Quality	Colour							
	Colour removal (%)	--						
	Turbidity (NTU)							
	Turbidity removal (%)	--						

*Camp number can be calculated from following formula if it cannot be read out from Jar Tester device.

Camp number = G·t

G: velocity gradient (s^{-1})

t: time of slow mixing (second)

Table 5: Optimal mixing strength.

NAME	JAR NUMBER / MIXING (RPM)
Jar number (beaker with the suitable mixing)	

© WorldSkills International

Table 6: Jat test data on optimum flocculant dosage.

DESCRIPTION	ITEM\JAR NO	RAW WATER	1	2	3	4	5	6
pH Adjustment	pH							
	Volume of alkali added (ml)	--						
	-- Concentration (mg/L)	--						
	Volume of acid added (ml)	--						
	-- Concentration (mg/L)	--						
	pH (after adjustment)	--						
Flocculant Dose	Volume of flocculant added (ml)	--						
	-- Concentration (mg/L)	--						
Clarifying Water Quality	Colour							
	Colour removal (%)	--						
	Turbidity (NTU)							
	Turbidity removal (%)	--						

Table 7: Optimal dosage of flocculant.

NAME	JAR NUMBER
Jar number (beaker with the best clarified water quality):	

Table 8: Resource sustainability and waste generation.

ITEM	QUANTITY
Quantity of pipette tips used (Pieces) (Inclusive of all tips, e.g., 1mL and 5 mL tips)	

© WorldSkills International

Table 9: Time Used for the Task.

TIME	TIME CHECK
End time (hh / mm)	
Duration (min)	
Checked by	Expert Name/Signature

Marking Scheme

The task evaluation will be made according to the Competition Information System (CIS) of Water Technology 2026.

End.