



## **Manual for the practical testing of units of learning outcomes for the competence profile Process Operator project PILE UP**

The Pile Up project has developed a common European competence profile for all European countries for Process Operators and Starting Maintenance Technicians in the chemical industry. The underlying goal is to facilitate the assessment of the knowledge, skills and competences of foreign employees to make them more employable in companies.

The Units of Learning Outcomes (ULO) were summarized by a European working group of learning outcomes of professional profiles. The learning outcomes describe the knowledge, skills and competencies required for each job.

The units of learning outcomes represent an instrument that can be used to test the required knowledge, skills and competencies of an employee to perform a work task or the requirements that can be found at a workplace in a simple way.

In this manual, the procedure of creating an assessment tool for a work item, to the conduct of the test and its evaluation is described, using the example of the Chemical Operator.

### **1. Selection of the work task**

The work task that got to be tested should be selected in the daily work process through a typical work-out. In the selection of the task should be taken to ensure that the test should take no longer than two to three hours. The assessment of a greater worktask should be divided into sections that can be tested on different days or in a theoretical interview.

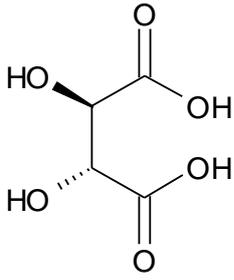
The task is assigned to each unit of learning outcomes (ULO). For the profession of chemical operator, the following units of learning outcomes have been developed in the framework of the Pile Up project.

<b>ULO 1 Execute internal logistics</b>
<b>ULO 2 Conduct processes</b>
<b>ULO 3 Participate in quality control</b>
<b>ULO 4 Execute first-line maintenance and repairs</b>

## 2. Formulation of a work task on the example production of sodium tartrate

The example of an selected task described here, was a test task for final examine of chemical operators, which was performed at the technical plant. The task is for the most part of the contents of the unit of learning outcomes 2 "conduct processes" and a small amount of ULO 3 "Participate in quality control". The test task was described as follows:

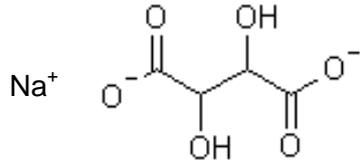
**Production of sodium tartrate  
by neutralization of NaOH with tartaric acid**



$C_4H_6O_6$

+ 2 NaOH

→



$C_4H_4Na_2O_6$

+ 2 H<sub>2</sub>O

Produce  $V = 7,0$  L of sodium hydroxide solution with a concentration of  $c = 0,3 \text{ mmol} \cdot \text{mL}^{-1}$ . Tartaric acid should be used for the neutralization. The neutralization shall be made up to pH = 7.0.

1. Calculate the amount of sodium hydroxide which is necessary for producing the sodium hydroxide solution of their predetermined molar concentration. Set against the result of an examiner for checking.
2. Calculate an equivalent amount of tartaric acid, which is required for neutralization. Set against the result of an examiner for checking.
3. Start the chemical plant.
4. Fill the container B1 with about 3 liters of deionized water from the supply system. Now determine an output limitation in manual operation mode of the pH controller, which allows you to meter the tartaric acid slowly.
5. Empty all containers of the test system into the wastewater. An examination of the waste water is not necessary.
6. Set up the required volume of sodium hydroxide solution with the given molar concentration. (B4)
7. Determining the power requirement for the agitator at 50, 100, 150 and 200  $\text{min}^{-1}$ . Make graphically represents the power required depending on the speed.

$P = M_d \cdot 2 \cdot \pi \cdot n$

For viewing the Reynolds number must be included.

$$Re = \frac{n \cdot d^2 \cdot \rho}{\eta}$$

For the calculation and graphical presentation using MS Excel! Then decide which speed is suitable for neutralization. Set the speed determined for the neutralization process.

8. Loosen the tartaric acid portion in a defined volume of deionized water. Remove a sample of tartaric acid and determine the density.
9. Calculating the target value of the density of the density-tartaric acid, according to concentration diagram. Calculate the absolute and relative errors of the concentration of your tartaric acid.
10. Now carry out the neutralization in manual mode. For the display of pH using an external pH meter. The meter is calibrated.
11.
 

Configure the controller for the heating in B4 and heat the salt solution in the automatic mode at 40 ° C. After reaching the desired value, keep it constant for 10 min. Then the brine is cooled in manual mode at 25 ° C and kept constant for 10 min. Export the trend display in MS Excel and make the thermostating graphically dar. Identify the following phases:

  - Heating up
  - Keep temperature
  - Cooling
  - Keep temperature
12. Filter the sodium tartrate solution for 5 min in the circulation.
13. The Audit Committee receives your 120 g sodium tartrate solution. The remaining solution can be disposed of without examination into the wastewater.
14. Rinse all parts of the plant used twice with deionized water. Remove the filter unit and clean it. It is equipped with a new filter cloth to reassemble and then be subjected to a leak test. For this test, an examiner should be consulted.
15. Fill B4 with 8 L of deionized water. Take the test system out of service and set the protocol completed.  
The Excel documents are printed.

In order to analyze the necessary knowledge, skills and competences to perform the work task in a better way, it can be converted min the matrix, which was developed within the CREDCHEM project.

In this matrix every work step is assigned to the relevant skills and abilities, and the necessary expertise.



**Task: ULO2-1.3.2 Production of sodium tartrate by neutralization of NaOH with tartaric acid**

<b>Practical Knowledge</b> Characterization of the workflow		<b>Expertise</b> Characterization of the work system	
<b>workflow</b>	<b>skills/abilities</b>	<b>scientific context</b>	<b>technological context</b>
The operator analyzes the current task schedule.	Reflecting on acquired knowledge. Planning of the working process.	Acid-base-reactions, adjusting an pH-value.	Controlling the infeeding valve by help of a pH-value measuring electrode.
The operator scales raw material.	Compiling the neutralization equation (chemical equation) and the resulting required amounts of chemicals taking into account the specifics of the equipment.	Chemical equations, acid-base-reactions.	Specifics of the equipment.
The operator informs himself about potential risks of the deployed chemicals and uses the respective PPE.	Abiding by workplace safety regulations. Choosing respective PPE.	Potential risks of the deployed chemicals.	
The operator weighs in the required quantities.	Operating a scale.	Basics of EI&C-technology.	Operating a scale.
The operator initiates the process by starting up, filling and tempering the equipment.	Recognizing technological core processes and their analysis.		The operator initiates the process by starting up, filling and tempering the equipment.
The operator checks the controller	Technically correct adjustment of		Controller settings.



setting.	controller valves.		
Dissolve the sodium hydroxide.		Solubility of sodium hydroxide in water.	
Determine the required stirrer for different speeds and derive the optimal setting.	Determining optimal stirrer speed.		Power requirements in relation to speed. $P = Md \cdot 2 \cdot \pi \cdot n$
Preparing the solution of tartaric acid.	Proper addition of tartaric acid in compliance with safety regulations.	Solubility of tartaric acid in water.	
Sampling and determination of density using areometer.	Proper removal of tartaric acid solution and determining the density in compliance with safety regulations.	Comparison of actual and set point. Calculation of the absolute and relative error.	
The operator conducts the neutralization, watches the experiment and adjusts the infeed speed as it is needed.	Watching the process, interfering at disturbances.		Using the available EI&C- and process control systems.
Perform and document the prescribed tempering modus.			Using the available EI&C- and process control systems.
Filtering the solution and bottle the solution of sodium tartrate.	Instruction to filtration and bottling in compliance with safety regulations		
The operator writes a protocol.	Documentation of results.		
The operator cleans the equipment.			
The operator shuts down the equipment.			



### 3. Use of Assessment-Tool

For testing the competences of each unit of learning outcome there is an assessment tool available. In this the competences and the skills of the ULO are registered. For the example the ULO3 "Participate in quality control" is used. In the example work task the quality control should be performed by a target-value comparison. It is both the sampling and the proper application of the aerometer for determining of density.

<b>Practical Knowledge</b> Characterization of the workflow		<b>Expertise</b> Characterization of the work system	
<b>workflow</b>	<b>skills/abilities</b>	<b>scientific context</b>	<b>technological context</b>
Sampling and determination of density using aerometer.	Proper removal of tartaric acid solution and determining the density in compliance with safety regulations.	Comparison of actual and set point. Calculation of the absolute and relative error.	

#### Explanation on the assessment form

Overall, the template for testing the ULO 3 includes twenty points which competences and / or skills and abilities from the description of the unit of learning outcomes are associated. In the first lines the information about the employee, the company, the auditor, the exam location and the exam date can be filled in. In the Work assignment field the tested work task should be called and the time that be required to process the task. The first column on the left contains the competencies of the unit of learning outcomes. In the second column the necessary steps to be entered by the responsible company employees. In column "skills/abilities" the skills and abilities of the ULO 3 are described. The next three columns are discussed in detail in the next chapter. The last column is used to document the test method for each work step. Here, in addition to the practical implementation the steps could be examined theoretically by means of interviews, etc



<b>Name:</b>		<b>Company / Department:</b>		<b>Personal-ID:</b>			
<b>Tester:</b>		<b>Test location:</b>		<b>Date:</b>			
<b>Work assignment (company related)</b>		<b>Evaluated criteria</b>		<b>judgement</b>			
<b>Assessment ULO 3</b>		<b>Participating in quality control</b>		<b>EQF level 4</b>	<b>EQF level 3</b>	<b>failed</b>	<b>Test method*</b>
<b>Work task ...</b>							
<b>Time available : . . . . . minutes</b>							
<b>Competences</b>	<b>Work steps (to be filled in by the company)</b>	<b>Nr.</b>	<b>Skills/abilities</b>	<b>EQF level 4</b>	<b>EQF level 3</b>	<b>failed</b>	<b>Test method*</b>
		1.	Distinguish of processes for taking and preparing samples for in process control und final product check				
Assume responsibility for choosing the right sampling method		2.	Pick and reason the required method for sample taking				
Take responsibility for abiding by safety regulations.		3.	Prepare samples und sampling devices as well as specifics of the equipment and safety regulations				
Autonomously take samples from the equipment correctly		4.	Take samples				
Autonomous execution of packing and storing.		5.	Pack and store samples correctly.				
Assume responsibility for the correct documentation		6.	Compile a documentation for the samples				
Assume responsibility for passing on samples		7.	Organize and documents the passing on of samples to the lab				
		8.	Interpret decisive specifications for quality purposes				
Autonomous execution of analyses		9.	Executing analyses at production process				



		10.	Presenting and evaluating results of an analysis				
		11.	Deduce characteristics for quality of the product				
Supervise the working process		12.	Evaluate deviations depending on the qualitative goal				
Take responsibility for the documentation of results.		13.	Present measured results in technically correct form				
Proactively inform the involved team		14.	Report on the results and the respective conclusions				
Autonomously execute possibilities of mending deviations		15.	Executing adjustments of equipment parameters				
Supervise the working process		16.	Evaluate the interventions on the equipment by taking and analysing samples again				
Take responsibility for passing on information		17.	Report deviations and started ramifications to supervisors				
Autonomously supervise the working process and recognize potential for optimization		18.	Deduce possibilities to augment quality specifically for the process together with his colleagues				
Autonomously execute methods of process development and optimization (GMP and GLP)		19.	Apply models and methods of process development and optimization (gmp, glp)				
Autonomously consider the regulations		20.	Integrate regulations into the process				

The company enters the work steps that are necessary to perform the work task in the second column. It is important to ensure that the work steps are mapped to the appropriate competences and / or the skills and abilities.



<b>Name:</b>		<b>Company / Department:</b>		<b>Personal-ID:</b>			
<b>Tester:</b>		<b>Test location:</b>		<b>Date:</b>			
<b>Work assignment (company related)</b>		<b>Evaluated criteria</b>		<b>judgement</b>			
<b>Assessment ULO 3</b>  <b>Work task Determining densities via areometers in various solutions</b>  <b>Time available : 10 minutes</b>		<b>Participating in quality control</b>		<b>EQF level 4</b>	<b>EQF level 3</b>	<b>failed</b>	<b>Test method*</b>
<b>Competences</b>	<b>Work steps (to be filled in by the company)</b>	<b>Nr.</b>	<b>Skills/abilities</b>				
	The operator analyses the current task schedule	1.	Distinguish of processes for taking and preparing samples for in process control und final product check				
Assume responsibility for choosing the right sampling method	Providing an aerometer, measuring cylinder and the samples to be measured.	2.	Pick and reason the required method for sample taking				
Take responsibility for abiding by safety regulations.	Researching safety regulations concerning the solutions that are to be measured	3.	Prepare samples und sampling devices as well as specifics of the equipment and safety regulations				
Autonomously take samples from the equipment correctly	Taking sample of given solutions.	4.	Take samples				
Autonomous execution of packing and storing.	Filling the sample into the measuring cylinder. Heating the contents to 20 °C via thermostat.	5.	Pack and store samples correctly.				



Assume responsibility for the correct documentation	<b>X</b>	6.	Compile a documentation for the samples				
Assume responsibility for passing on samples	<b>X</b>	7.	Organize and documents the passing on of samples to the lab				
	<b>X</b>	8.	Interpret decisive specifications for quality purposes				
Autonomous execution of analyses	Using the test spindle to determine the right aerometer spindle. Handling the aerometer spindle technically correct and determine the respective density. Cleaning the spindle.	9.	Executing analyses at production process				
	Documentation of the result of measurement.	10.	Presenting and evaluating results of an analysis				
	<b>X</b>	11.	Deduce characteristics for quality of the product				
Supervise the working process	<b>X</b>	12.	Evaluate deviations depending on the qualitative goal				
Take responsibility for the documentation of results.	Documentation of the result of measurement.	13.	Present measured results in technically correct form				
Proactively inform the involved team	<b>X</b>	14.	Report on the results and the respective conclusions				
Autonomously execute possibilities of mending deviations	<b>X</b>	15.	Executing adjustments of equipment parameters				
Supervise the working process	<b>X</b>	16.	Evaluate the interventions on the equipment by taking and analysing samples again				
Take responsibility for passing on information	Documentation of the result of measurement.	17.	Report deviations and started ramifications to supervisors				



Autonomously supervise the working process and recognize potential for optimization	<b>X</b>	18.	Deduce possibilities to augment quality specifically for the process together with his colleagues				
Autonomously execute methods of process development and optimization (GMP and GLP)	<b>X</b>	19.	Apply models and methods of process development and optimization (GMP, GLP)				
Autonomously consider the regulations	<b>X</b>	20.	Integrate regulations into the process				

Now it is clear that not all skills, abilities and competencies that are described in the unit of learning outcomes are needed to perform the work task, so this lines can be omitted. Thus, the abbreviated submission for consideration of the employee is more manageable.

<b>Name:</b>		<b>Company / Department:</b>		<b>Personal-ID:</b>			
<b>Tester:</b>		<b>Test location:</b>		<b>Date:</b>			
<b>Work assignment (company related)</b>		<b>Evaluated criteria</b>		<b>judgement</b>			
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<b>Work task Determining densities via areometers in various solutions</b>							
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<b>Competences</b>	<b>Work steps (to be filled in by the company)</b>	<b>Nr.</b>	<b>Skills/abilities</b>				
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Assume responsibility for choosing the right sampling method	Providing an aerometer, measuring cylinder and the samples to be measured.	2.	Pick and reason the required method for sample taking				
Take responsibility for abiding by safety regulations.	Researching safety regulations concerning the solutions that are to be measured	3.	Prepare samples and sampling devices as well as specifics of the equipment and safety regulations				
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Autonomous execution of analyses	Using the test spindle to determine the right aerometer spindle. Handling the aerometer spindle technically correct and determine the respective density. Cleaning the spindle.	6.	Executing analyses at production process				
	Documentation of the result of measurement.	7.	Presenting and evaluating results of an analysis				
Take responsibility for the documentation of results.	Documentation of the result of measurement.	8.	Present measured results in technically correct form				
Take responsibility for passing on information	Documentation of the result of measurement.	9.	Report deviations and started ramifications to supervisors				



#### 4. Evaluation of examination

European Qualifications Framework EQF is an initiative of the European Union (EU), which is to make vocational qualifications and competences in Europe comparable.

By defining a grid of the EQF is to serve as a "translator" between the qualification systems of the Member States so that educational qualifications for employers, individuals and institutions been made more readable and understandable, and workers and learners can use their qualifications in other countries.

The assessment of the service provided based on the criteria of the European Qualifications Framework (EQF) in order to achieve a Pan-European comparability in the assessment of skills, capabilities and competencies of the employees can.

In the chemical production usually employees with EQF level 4 or 3 are needed, as it is registered the column below.

Level EQF	Knowledge	Skills	Competences
3	Knowledge of facts, principles, processes and general concepts, in a field of work or study	a range of cognitive and practical skills required to accomplish tasks and solve problems by selecting and applying basic methods, tools, materials and information	take responsibility for completion of tasks in work or study; adapt own behaviour to circumstances in solving problems
4	Factual and theoretical knowledge in broad contexts within a field of work or study	a range of cognitive and practical skills required to generate solutions to specific problems in a field of work or study	exercise self-management within the guidelines of work or study contexts that are usually predictable, but are subject to change; supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities



The following table show main criteria of level 3 and 4 Operator. These criteria can be used next to the assessment tool.

Level EQF	Core task	Characteristic Criteria	Function and Behaviour
3	Mastering production process	<ul style="list-style-type: none"><li>• Follow instructions and procedures.</li><li>• Use of materials and resources</li><li>• Deliver quality</li></ul>	Autonomously execute and perform the daily work as described in the assessment tool
4	Participate in process improvement and product development	<ul style="list-style-type: none"><li>• Coordinate work and instruct employees</li><li>• Create and innovate</li><li>• Investigate</li></ul>	Autonomously execute end perform the daily work as described in the assessment tool. Initiate improvement and take responsibility for optimization of the process.

## 5. Summary

The assessment tool provide an effective and easy measurement which may represent the gaps in competences of Chemical Operators of EQF level 3 and 4.

Through the European standardization of Chemical Operators the gaps in competences may be “*piled up*” by vocational education. The main goal is to obtain optimal conditions to exchange employees in the Chemical Production area within Europe.

For further questions please contact the partner from the Pile Up project available.

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