

BIOGAS PLANT TECHNICIAN FIXED DOME

Competency Standards

National Vocational
Certificate Level 2

Version 1 - December 2014

Published by

National Vocational and Technical Training Commission
Government of Pakistan

Headquarter

Plot 38, Kirthar Road, Sector H-9/4, Islamabad, Pakistan
www.navttc.org

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Layout & design

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This document has been produced with the technical assistance of the TVET Reform Support Programme, which is funded by the European Union, the Embassy of the Kingdom of the Netherlands, the Federal Republic of Germany and the Royal Norwegian Embassy and has been commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ). The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH in close collaboration with the National Vocational and Technical Training Commission (NAVTTTC) as well as provincial Technical Education and Vocational Training Authorities (TEVTAs), Punjab Vocational Training Council (PVTC), Qualification Awarding Bodies (QABs) and private sector organizations.

Document Version

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Table of contents

Competency Standards: Biogas Technicians (Fixed Dome Biodigesters)	4
Standard-1: Recall basic concepts of biogas production and benefits of biodigester technology.....	4
Standard 2: Read and interpret drawings of fixed dome biodigesters	6
Standard 3: Select suitable type and appropriate size of biodigester and carry out basic calculations	7
Standard 4: Select construction materials and construction site	9
Standard 5: Construct civil engineering component of a fixed dome biodigester	11
Standard 6: Install Pipeline and electro-mechanical components	13
Standard 7: Perform routine operation and minor maintenance tasks	15
Standard 8: Practice quality norms and ensure the compliance of quality standards while construction.....	17
List of Tools, Machinery & Equipment	18
List of Consumable Supplies	19
Worker Traits and Related Knowledge	20

Competency Standards: Biogas Technicians (Fixed Dome Biodigesters)

Standard-1: Recall basic concepts of biogas production and benefits of biodigester technology.

Overview: These competency standards will ensure that the trainees will be able to explain process of biogas production, types of biodigesters and importance of biogas technology in Pakistan

Competency Unit	Performance Criteria	Knowledge and Understanding
C1.1: Explain prerequisites for biogas generation	<p>P1: Explain methods of biogas production</p> <p>P2: Explain different types of inputs (feeding materials) for biodigesters</p> <p>P3: Explain merits and demerits of different feeding materials</p> <p>P4: Describe why cattle dung is the best feeding material for Pakistan context</p> <p>P5: Explain ideal conditions for biogas generation</p> <p>P6: Describe effects of temperature on biogas generation</p>	<p>The participants will be able to understand:</p> <p>K1: Basic bacterial activities to produce biogas</p> <p>K2: Different types of inputs to operate a biodigester</p> <p>K3: Merits and demerits of different feeding materials</p> <p>K4: Reasons for using cattle dung as the main feeding material in Pakistan</p> <p>K5: Methods and prerequisites to ensure effective biogas production</p> <p>K6: Suitability of biodigester in different climatic conditions</p>
C1.2: Describe types and functioning/ working of biodigesters	<p>P1: Describe different types of biodigesters and their strengths and weaknesses</p> <p>P2: Explain components of a fixed dome biodigester and function(s) of each component</p> <p>P3: Explain inter-relations of different components of a fixed dome biodigester</p> <p>P4: Describe the criteria to select a particular model of fixed dome biodigesters</p> <p>P5: Explain suitability of fixed dome designs for electricity generation</p>	<p>K1: Different types of biodigesters and their comparative advantages</p> <p>K2: Components and functions of a fixed dome biodigesters</p> <p>K3: Working principle of a fixed dome biodigester</p> <p>K4: Merits and demerits of different designs of fixed dome biodigesters in particular context</p> <p>K5: Strengths and weaknesses of fixed dome design for electricity generation</p>

<p>C1.3: Describe benefits of biodigesters and importance of the technology in Pakistan</p>	<p>P1: Explain the products of a biodigester</p> <p>P2: Recall various end use applications of biogas</p> <p>P3: Recall advantages of bioslurry over FYM</p> <p>P4: Explain benefits of biogas at household, community and commercial levels</p> <p>P5: Explain why biodigester technology is important for Pakistan</p>	<p>K1: Products/outputs of biodigesters – Biogas and bioslurry</p> <p>K2: Different biogas end-use applications – cooking, lighting, running an engine</p> <p>K3: Comparative advantage and disadvantages of FYM and bioslurry</p> <p>K4: Benefits of biogas over conventional fuel sources</p> <p>K5: General energy situation in Pakistan</p>
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Standard 2: Read and interpret drawings of fixed dome biodigesters

Overview: This competency standard ensures that the participants are familiar with different types of drawings and they are able to read and interpret drawings of fixed dome biodigesters.

Competency Unit	Performance Criteria	Knowledge and Understanding
C2.1: Describe the basic concepts of a drawing of an object	P1: Tell why drawing is needed P2: Describe the concept of plan, elevation and sections while preparing drawings	K1: The need and importance of drawing K2: Notions of plan, elevation and sections of a drawing
C2.2: Demonstrate ability to read basic drawings	P1: Explain the concept of foot-inch and meter-centimeter system of measurement P2: Demonstrate ability to distinguish different types of drawings	K1: Different systems of measurement and use of measuring tape K2: Different types of drawings – isometric view, sectional elevations, plan, elevation etc.
C2.3: Demonstrate ability of interpret drawing of fixed dome biodigesters	P1: Describe the dimensions of various components of a fixed dome biodigesters P2: Define plan, section, isometric view, and half sectional elevation of biodigesters P3: Describe inter-relationship of various components of a biodigester	K1: Working of biodigester, its components and dimension of various parts. K2: Methods of reading drawings of different components of a fixed dome biodigester K3: Inter-relationship of various biodigester components
C2.4: Read and interpret drawings of templates, appliances, pipes and fittings and filter systems	P1: Read drawings of various sizes of templates P2: Read drawing of mixing devices P4: Read drawing of biogas stoves and lamps P5: Read drawings of pipes and fittings P6: Read drawings of filter systems	K1: Templates and their uses K2: Mixing device and its use K3: Biogas stoves and lamps K4: Pipes and fittings such as tee, elbow, nipple, valves, socket K5: H ₂ S filter, moisture filter, CO ₂ filter

Standard 3: Select suitable type and appropriate size of biodigester and carry out basic calculations

Overview: This competency standard ensures that the participants are familiar with different criteria to be considered while selecting best suitable type and size of a biodigester and be able to carry out simple calculations,

Competency Unit	Performance Criteria	Knowledge and Understanding
C3.1: Select suitable type of biodigester	<p>P1: Explain pre-requisite for the selection of biodigester type such as consideration on durability, reliability, affordability, user-friendliness for construction and operation</p> <p>P2: Describe suitability of different designs in specific site conditions</p>	<p>K1: Criteria to select suitable type of biodigester</p> <p>K2: Different designs of fixed dome biodigester and their suitability in different context</p>
C3.2: Select suitable size of biodigester	<p>P1: Explain pre-requisite for the selection of biodigester size</p> <p>P2: Estimate the quantity of feeding materials (cattle dung) available and gas production</p> <p>P3: Estimate the quantity of gas required based upon end-use applications</p> <p>P4: Select suitable size of biodigester based upon main selection criteria</p>	<p>K1: Criteria to select suitable size of biodigester</p> <p>K2: Calculation of quantity of feeding materials and gas production</p> <p>K3: Various end-use application and gas requirements</p> <p>K4: Different sizes of biodigesters and gas production</p>
C3.3: Carry out basic calculations	<p>P1: Practice addition, subtraction and multiplication of measurement units</p> <p>P2: Calculate cost and quantity estimation of biodigesters</p> <p>P3: Describe the quantity of various construction materials needed for different sizes of biodigesters</p>	<p>K1: Basic addition, subtraction and multiplication</p> <p>K2: Use of calculators</p> <p>K3: Types and quantity of construction materials needed for construction</p>
C3.4: Interpret the relation between HRT,	P1: Describe the effect of HRT on size selection	K1: Concept of HRT and its effect on size

quantity of feeding materials and required size of biodigester	P2: Explain relation between quantity of feeding and HRT P3: Select size of biodigester based upon feeding materials and estimated HRT	selection K2: Types of feeding materials and estimated HRT K3: Different sizes of biodigesters and quantity of feeding materials needed.
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Standard 4: Select construction materials and construction site

Overview: This competency standard ensures that the participants are able to name the construction materials required for the construction of a fixed dome biodigester and select construction materials to comply with the set quality standards.

Competency Unit	Performance Criteria	Knowledge and Understanding
C4.1: Name different types of construction materials needed for constructing a fixed dome biodigester	P1: State the type of construction materials needed for construction	K1: Different construction materials needed for fixed dome biodigesters
C4.2: Appraise quality standards of construction materials	P1: Describe quality standards of bricks and stones P2: Describe quality standards of cement P3: Describe quality standards of sand P4: Describe quality standards of aggregate/gravel P5: Describe quality standards of MS rod P6: Describe quality standards of acrylic emulsion paint	K1: Types and quality of bricks and stones and their uses, hitting and abrasion tests K2: Cement grade and OPC, storing and handling of cement K3: Bottle test for assessing quality of sand, calculations of % of impurity in sand K4: Different sizes of aggregate and their uses K5: Types of MS rod and their uses K6: Characteristics of acrylic, methods to apply paint
C4.3: Explain criteria for selection of construction site	P1: Explain why biodigester should be constructed near cattle shed P2: Explain why biodigester should be located in sunny place P3: Explain why the distance between biodigester and point of use should be as minimum as possible P4: Explain why biodigester should not be constructed too close to foundation of structures, growing trees, main trail and machines producing vibrations P5: Explain why biodigesters should not be	K1: Effects of long distance between digester and cattle shed on feeding of biodigester K2: Effect of outside temperature on digester temperature K3: Effect of longer conveyance system on installation cost and operation and maintenance K4: Safety in construction, potential damage to biodigester because of roots of a tree and vibrating machines.

	<p>constructed in water logging areas and slide-prone areas</p> <p>P6: Explain the characteristics of best site for constructing biodigesters</p>	<p>K5: Potential danger of flooding and cracking of digesters because of water logging and ground movements</p> <p>K6: Basic criteria to select best site for construction</p>
<p>C4.4: Explain steps (sequences) of construction of a fixed dome biodigester</p>	<p>P1: Describe methods of construction of different components of a fixed dome biodigester</p> <p>P2: Describe relative positioning of different components of a fixed dome biodigesters</p> <p>P3: Explain the importance of reference line</p>	<p>K1: Biodigester construction and sequence of construction activities</p> <p>K2: Functioning of different components of a fixed dome biodigesters</p> <p>K3: Reference line and its use during construction</p>

Standard 5: Construct civil engineering component of a fixed dome biodigester

Overview: This competency standard ensures that the participants are able to construct civil structures of a fixed dome biodigester complying with set quality standards.

Competency Unit	Performance Criteria	Knowledge and Understanding
C5.1: Construct digester	<p>P1: Demonstrate methods for lay out (demarcation) of biodigester</p> <p>P2: Supervise the excavation of pit</p> <p>P3: Prepare mortar</p> <p>P4: Prepare base of the digester and construct foundation</p> <p>P5: Construct digester walls</p> <p>P6: Fix inlet pipes</p> <p>P7: Plaster digester walls</p> <p>P8: Maintain plumb of digester wall</p>	<p>K1: Use and interpretation of drawing, measurement and marking</p> <p>K2: Pit diameter and depth, excavation tools and their uses</p> <p>K3: Mixing ratio and methods of preparing mortar of different ratio</p> <p>K4: Methods of leveling, compacting and ramming</p> <p>K5: Use of different construction tools and equipment, masonry skills</p> <p>K6: Location and fixation of inlet pipes</p> <p>K7: Plastering skill, ratio of mortar</p> <p>K8: Proper use of plumb-bob</p>
C5.2: Construct gas holder and turret	<p>P1: Prepare scaffolding and formworks for dome casting</p> <p>P2: Select and use proper size of templates</p> <p>P3: Prepare mortar and cast gas holder</p> <p>P4: Remove scaffolding and frameworks</p> <p>P5: Carry out inside plastering of gas holder</p>	<p>K1: Fitting of scaffolding and formworks for casting gas holder</p> <p>K2: Sizes and uses of templates</p> <p>K3: Mixing ratio and methods of preparing mortar of different ratio, methods of casting concrete</p> <p>K4: Safety precautions while removing scaffoldings/frameworks</p> <p>K5: Gas tightness and methods to apply different layers of plasters to ensure leak-proof gas holder</p>

<p>C5.3: Construct manhole, outlet/ hydraulic chamber</p>	<p>P1: Maintain correct size of manhole P2: Construct outlet walls P3: Plaster outlet walls P4: Maintain plumb of outlet wall P5: Cast concrete cover slab for outlet and fit in place</p>	<p>K1: Methods of constructing manhole K2: Proper use of different construction tools and equipment, masonry skills K3: Plastering skill, ratio of cement and sand on mortar K4: Proper use of plumb-bob K5: Mixing ratio and methods of preparing mortar of different ratio, methods of casting concrete</p>
<p>C5.4: Construct inlet and mixing tank</p>	<p>P1: Construct platform for inlet tank P2: Construct walls of inlet tank P3: Plaster inlet tank P4: Fix mixing device</p>	<p>K1: Use of different construction tools and equipment, masonry skills K2: Types of masonry works K3: Plastering skill, ratio of sand and cement on mortar K4: Fixation and use of vertical and horizontal mixture machines</p>
<p>C5.5: Construct slurry collection and composting pit</p>	<p>P1: Select location of slurry collection and composing pit P2: Decide the size of collection and composing pits P3: Supervise excavation of pits P3: Construct walls and roof of the pits</p>	<p>K1: Methods of handling and application of bioslurry K2: General thumb rule to decide the size of slurry pit K3: Pit dimensions, excavation tools and their uses K3: Proper use of different construction tools and equipment, masonry skills</p>

Standard 6: Install Pipeline and electro-mechanical components

Overview: This competency standard ensures that the participants are able to install biogas conveyance system, biogas filtration system and biogas utilization system as per set quality standards.

Competency Unit	Performance Criteria	Knowledge and Understanding
C6.1: Install pipeline	<p>P1: Describe quality standard of pipes and fittings</p> <p>P2: Select correct size of pipes and fitting</p> <p>P3: Select best alignment for pipe laying</p> <p>P4: Join pipes using correct fitting and sealing agent</p> <p>P5: Protect pipeline against possible damage</p>	<p>K1: Quality standards of pipes and fittings</p> <p>K2: Selection of pipe-size based upon flow of gas and distance</p> <p>K3: Effect of longer pipe on cost as well as risk of biogas leakage</p> <p>K4: Plumbing skill, fixation of fittings and sealing agents such as Teflon tape</p> <p>K5: Methods to protect pipeline against possible damage</p>
C6.2: Install appliances/accessories	<p>P1: Name different types of biogas appliances and end use applications</p> <p>P2: Describe quality standards of appliances</p> <p>P3: Fix biogas stoves, lamps and other appliances as per users' need</p> <p>P4: Install pressure gauge, gas-flow meter and temperature gauge</p>	<p>K1: Types of biogas appliances such as stoves, lamps, water heaters, rice-cookers, generators</p> <p>K2: Quality standards of biogas appliances</p> <p>K3: Methods of fitting appliances, plumbing skills</p> <p>K4: Plumbing skill, functioning of pressure gauge, gas-flow meter and temperature gauge</p>
C6.3: Install gas filtration/purification system	<p>P1: Describe quality standards of filter system</p> <p>P2: Install CO₂ scrubber (for larger biodigesters, more than 100 cum)</p> <p>P3: Install H₂S remover</p> <p>P4: Install moisture removal</p>	<p>K1: Quality standards of biogas purification system</p> <p>K2: Plumbing skill, understanding of functioning of CO₂ scrubber and safe disposal of carbonated water</p> <p>K3: Plumbing skill, understanding of functioning of H₂S remover</p> <p>K4: Plumbing skill, understanding of functioning of moisture removal</p>

<p>C6.4: Install pump and/or generator</p>	<p>P1: Describe quality standards of pump/generator P2: Calculate gas demand and select suitable pump/generator size P3: Explain modifications of conventional machines to operate with biogas P4: Install pumping arrangements, generators, control systems and blowers/compressors</p>	<p>K1: Quality standards of pump/generators K2: Methods of calculating gas demand and suitable size of pump/generators K3: Working principle of biogas operated engines K4: Plumbing skill, working of biogas operated engines</p>
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Standard 7: Perform routine operation and minor maintenance tasks

Overview: This competency standard ensures that the participants are familiar with the routine operational activities as well as minor repair works and they are capable of imparting effective operation and maintenance training to biogas users.

Competency Unit	Performance Criteria	Knowledge and Understanding
C7.1: Describe routine operation activities for trouble-free functioning of biodigester	<p>P1: Prescribe correct quantity of feeding</p> <p>P2: Describe the effect of under-feeding and over-feeding</p> <p>P3: Demonstrate efficient use of different appliances such as water drain, main valve, gas taps</p> <p>P4: Perform leakage testing</p> <p>P5: Explain dos and don'ts dos for effective functioning of biodigesters</p>	<p>K1: Quantity of feeding/biodigester loading rate</p> <p>K2: Effects of underfeeding and overfeeding, change in HRT</p> <p>K3: Operation of different appliances, working principle of appliances</p> <p>K4: Leakage testing methods and protocols, use of soap-water solution, colour smoke etc.</p> <p>K5: dos and don'ts dos for effective functioning of biodigesters</p>
C7.2: Conduct minor repair and maintenance works	<p>P1: Demonstrate changing of washers</p> <p>P2: Perform greasing/oiling of gas taps</p> <p>P3: Perform minor repair of appliances</p> <p>P4: Perform repair of leaked pipeline</p>	<p>K1: Use of repair and maintenance tools</p> <p>K2: Greasing techniques</p> <p>K3: Working of appliances</p> <p>K4: Use of plumbing tools, and sealing agents</p>
C7.3: Identify potential problems and likely solutions	<p>P1: Demonstrate the use of pH meter, pressure meter, foot pump, gas flow meter to identify potential problems</p> <p>P2: Carry out pressure testing to detect biogas leakages</p> <p>P3: Inspect the colour of bioslurry, water dung ratio, flow pattern and odour of bioslurry to asses potential problems</p>	<p>K1: Functioning and use of testing tools and equipment</p> <p>K2: Pressure testing methods and protocols</p> <p>K3: Changes in slurry during the process of biogas formation.</p>

<p>C7.4: Explain methods for optimum utilization of biogas and bioslurry</p>	<p>P1: Describe different uses of biogas and biogas appliances P2: Identify potentials for diversification of biogas end use applications P3: Tell the effect of under-utilisation of biogas P4: Describe characteristics and benefits of bioslurry P5: Apply suitable methods for optimal utilisation of bioslurry P6: Describe the benefits of composting of bioslurry</p>	<p>K1: Different end-use applications and biogas consumption rates of different appliances K2: Various end-use applications of biogas K3: Potential harmful effect of biogas when escaped in atmosphere K4: Characteristics and benefits of bioslurry K5: Methods of bioslurry applications K5: Nutrient content on composted bioslurry and its comparative benefit over FYM</p>
<p>C7.5: Instruct users for effective operation and maintenance of biodigester</p>	<p>P1: Inform potential problems and likely solutions to users P2: Teach users to carry out effective operation works P3: Teach users to carry out minor repair and maintenance works</p>	<p>K1: Common/ potential problems to be encountered and likely solutions K2: Facilitation skill, effective operation activities K3: Facilitation skill, repair and maintenance skill</p>
<p>C7.6: Ensure sustainable benefits from biodigester</p>	<p>P1: Provide warranty to ensure long term functioning of biodigester P2: Perform timely after-sale services P3: Provide user's manual</p>	<p>K1: Guarantee provisions for biodigesters and criteria K2: Effective after-sale-services K1: Importance of user's manual</p>

Standard 8: Practice quality norms and ensure the compliance of quality standards while construction

Overview: This competency standard ensures that the participants are able to realize the importance of quality assurance and practice quality norms while construction. .

Competency Unit	Performance Criteria	Knowledge and Understanding
C8.1: Describe the importance of quality assurance	P1: Describe the definition of quality assurance while constructing biodigester P2: Explain why quality is needed while construction and installation P3: Explain how quality is maintained during construction	K1: Quality assurance norms and methods K2: Effect of sub-standard quality of work on functioning of a biodigester K3: Methods to maintain quality
C8.2: Practice quality norms during construction	P1: Explain quality standards to be complied while construction/installation P2: Comply with set quality standards while constructing biodigester	K1: Quality standards and norms K2: Methods to comply with quality standards and norms
C8.3: Describe the roles and responsibilities of a biogas technician	P1: Tell roles and responsibilities of a biogas technician while construction P2: Describe what happens if a biogas technician does not fulfil his/her responsibilities	K1: Internalization of roles and responsibilities of a biogas technician K2: Effects of sub-standard works on quality of end-product and functioning of a biodigester
C8.4: Practice occupational health and safety measures	P1: Demonstrate proper use of personal safety gears such as helmet, dongri, safety shoes, safety belt P2: Exhibit safe use of construction tools and equipment P3: Practice safety measures at works	K1: Types of safety gears and their uses during construction K2: Construction tools and equipment and their safe uses K3: General safety measures at work

List of Tools, Machinery & Equipment

Name of Trade		Training of Biodigester Technicians (Masons) to Construct Fixed dome Biodigesters for Running Pumps
Duration		Four weeks (24 days or 192 hours)
Sr. No.	Name of Item/ Equipment / Tools	Quantity
	Training Equipment	1
1.	Computer	1
2.	Over-head Projector with screen	1
3.	White board	1
4.	Model/prototype of biodigester	1
5.	Flip chard board and paper	1
6.	Camera	1
7.	Construction video/DVD	1
8.	Calculators	1
	Masonry Tools	
9.	Measuring tape – 5m and 30m length	5
10.	Plumb-bob	5
11.	Water level	2
12.	Mason's Trowel	25
13.	Plastering trowel- 2 types	5
14.	Pointing trowel	5
15.	Pick axe with handle	5
16.	Wheel barrow	2
17.	Chisel sets – 9" and 12"	5
18.	Mason's hammer	5
19.	Hammer – 1.5 kg and 3 kg	5
20.	Templates (different sizes according to size of biodigester)	2
21.	Straight Edge (4 ft long), metal or wooden	5
22.	Level pipe (transparent plastic)	2
23.	String/thread roll	5
24.	Lime for layout	5 kg
25.	Iron trough/mortar pan – GI 18" dia (for handling concrete, mortar)	10
26.	Line and pins	LS
27.	Spirit level	3
28.	Brushes (wire brush, painting brush)	10
29.	Shovel with handle	5
30.	Builders square	5

31.	Striker for horizontal and vertical joints	5
32.	Steel float – small, medium and large	5
33.	Wooden float – small, medium and large	5
34.	Mason's Tool bag	25
	Plumbing tools	
35.	Hexa-frame and blade sets	5
36.	Pipe wrench – 9" and 12"	2
37.	Plier/slide wrench	2
38.	Spanners	2
39.	Needle file	2
40.	Dice and vice set	1
	Personal Protective equipment	
41.	Helmet	25
42.	Dungaree (Working uniform)	25
43.	Safety belt	25
44.	Boots	25
45.	Gloves	25
46.	Rain coats	25
	Biogas Related Appliances/Equipment	
47.	Pressure meter	1
48.	Biogas analyser	1
49.	pH meter	1
50.	Thermometer with probes	1
51.	Foot or hand pump	1

List of Consumable Supplies

Name of Trade	Training of Biodigester Technicians (Masons) to Construct Fixed dome Biodigesters for Running Pumps	
Duration	Four weeks (24 days or 192 hours)	
Sr. No.	Name of Consumable Supplies (for a group of 25 participants)	Quantity
	Stationaries	
1.	Flip chart paper	60 sheets
2.	Meta cards – different colours	100 sheets
3.	Marker pens (Permanent and board marker)	10
4.	Masking tape (rolls)	5

5.	Cello tape	2
6.	Lime or marking powder	2 kg
7.	Biodigester drawing	25
8.	Construction manuals	25
9.	Operation manual	25
10.	Ball pen	35
11.	Pencils	35
12.	Erasers	35
13.	Writing pad/note book	25
14.	Glue stick	2
15.	Brochures of biodigester technology	50
16.	Bags	25
17.	White paper (A4)	1 rim
	Construction Materials and appliances for 20 m³ fixed dome biodigester	
18.	Cement	
19.	Bricks	
20.	Sand	
21.	Aggregates 20mm	
22.	Inlet pipes PVC 110 mm diameter 3 m long	
23.	MS Rod 10 mm diameter	
24.	Binding wire	
25.	Gas storage drum	
26.	Angle Iron for Guiding frames	
27.	Scaffolding	
28.	PVC/GI pipe and fittings as per site condition	
29.	Biogas filters (CO ₂ scrubber, H ₂ S remover, moisture remover)	
30.	Biogas appliances (as per sit condition and users' need)	
31.	Control valves – as per site condition	
32.	Main gas pipe – GI 1.5" diameter, 1 m long with reducing elbow	
33.	Teflon tape	
34.	Pressure gauge	
35.	Biogas flow meter	
36.	Temperature gauge	

Worker Traits and Related Knowledge

Traits:

- Physically fit/healthy
- Sincere

- Interactive
- Good listener
- Able to work under pressure and difficult circumstances
- Polite
- Cooperative
- Dedicated
- Working with humility
- Intuitive and creative
- Motivating
- Team-spirit
- Trustworthy
- Good communicator
- Influencing
- Hard working
- Out-spoken
- Helpful
- Friendly
- Proactive/ active

Related Knowledge:

- Basic principle of biogas generation
- Types and functioning of a biodigester
- Measurement, Units of measurements
- Basic mathematics/calculations
- Drawing reading an interpretation
- Masonry works/ construction methods
- Plumbing works
- Operation and functions of different biogas appliances
- Quality standards of construction materials and appliances
- Use of biogas
- Application of bioslurry
- Routine Operational activities
- Minor repair and maintenance of biodigester
- Potential problems and likely solution
- Gas filtering mechanisms
- Effective communication


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