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BIOGAS PLANT TECHNICIAN FIXED DOME

Competency Standards

National Vocational Certificate Level 3

Version 1 - December 2014

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Competency Standards: Biogas Technical Supervisors (Fixed Dome Biodigesters)

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

Overview: This competency standard will ensure that the trainees will be able to explain process of biogas production, micro-biological activities/process inside the biodigester, factor supporting and inhibiting 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	P1: Explain methods of biogas production P2: Explain different types of inputs (feeding materials) for biodigesters P3: Explain merits and demerits of different feeding materials P4: Describe why cattle dung is the best feeding material for Pakistan context	The participant will have knowledge and understanding of: K1: Basic bacterial activities to produce biogas, prerequisites for biogas production K2: Different types of inputs to operate a biodigester K3: Merits and demerits of different feeding materials K4: Reasons for the use of cattle dung as the popular feeding material for biodigesters
C1.2: Explain basic concept of micro-biological activities inside the biodigester	P1: Explain ideal conditions for biogas generation P2: Describe inhibiting factors for gas production P3: Describe the basic concept of waste-to-energy	K1: Effects of (i) temperature, (ii) pH, (iii) total solid (dilution factor) content, (iv) mixing quality, (v) carbon-nitrogen ratio, (vi) HRT and (vii) over and under-feeding on the production of biogas K2: Microbiological activities and effect of toxicity and aerobic condition on biogas generation K3: Different organic and inorganic wastes and management of waste

C1.3: Describe types and functioning/ working of biodigesters	P1: Describe different types of biodigesters and their strengths and weaknesses P2: Explain components of a fixed dome biodigester and function(s) of each component P3: Explain inter-relations of different components of a fixed dome biodigester P4: Describe the criteria to select a particular model of fixed dome biodigesters P5: Explain suitability of fixed dome designs for electricity generation	K1: Different types of biodigesters and their comparative advantages K2: Components and functions of a fixed dome biodigesters K3: Working principle of a fixed dome biodigester K4: Merits and demerits of different designs of fixed dome biodigesters in particular context K5: Strengths and weaknesses of fixed dome design for electricity generation
C1.4: Describe benefits of biodigesters and importance of the technology in Pakistan	P1: Explain the products of a biodigester P2: Recall various end use applications of biogas P3: Recall advantages of bioslurry over FYM P4: Explain benefits of biogas at household, community and commercial levels P5: Explain why biodigester technology is important for Pakistan	K1: Output/ products of biodigesters – Biogas and bioslurry K2: Different end-use application of biogas – cooking, lighting, running an engine K3: Comparative advantage and disadvantages of FYM and bioslurry K4: Benefits of biogas over conventional fuel sources K5: General energy scenario/situation in Pakistan

Standard 2: Describe basic concept of designing a fixed dome biodigesters and perform cost and quantity estimation

Overview: This competency standard ensures that the participants are familiar with the concept of designing a fixed dome biodigester and they are able to calculate cost and quantity estimation of different sizes of fixed dome biodigesters.

Competency Unit	Performance Criteria	Knowledge and Understanding
C2.1: Describe basic criteria for designing a fixed dome biodigesters	P1: Describe the relationship between feeding material (quantity and quality) and type and size of biodigester P2: Describe the steps of designing a fixed dome biodigester P3: Describe effects of the characteristics of construction site (site condition) on design	K1: Feeding requirements for a specific size of biodigester, importance of HRT K2: Sequential steps to design a fixed dome biodigester K3: Site information that need to be collected before staring the design
C2.2: Interpret the relation between HRT, quantity of feeding materials and required size of biodigester	P1: Describe the effect of HRT on size selection P2: Explain relation between quantity of feeding and HRT P3: Select size of biodigester based upon feeding materials and estimated HRT	K1: Concept of HRT and its effect on size selection K2: Types of feeding materials and estimated HRT K3: Different sizes of biodigesters and quantity of feeding materials needed.
C2.3: Carry out quantity estimation of different sizes of fixed dome biodigester	P1: Practice basic mathematical calculations P2: Describe the quantity of various construction materials needed for different sizes of biodigesters P3: Prepare detailed quantity estimation of fixed dome biodigesters	K1: Basic addition, subtraction and multiplication and division , Use of calculators K2: Types and quantity of construction materials needed for construction K3: Quantity estimation format, norms and methods, use of calculators
C2.4: Carry out cost estimation of different sizes of fixed dome biodigester	P1: Collect information on market process of construction materials P2: Prepare detailed cost estimation of fixed dome biodigesters	K1: Market prices of various construction materials K2: Cost estimation formats, norms and methods, use of calculators

Standard 3: 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
C3.1: 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: Notion of plan, elevation and sections of a drawing
C3.2: 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.
C3.3: 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: Functioning 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
C3.4: 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_2S filter, moisture filter, CO_2 filter

Standard 4: Select suitable type and appropriate size of biodigester

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
C4.1: Select suitable type of biodigester	P1: Explain pre-requisite for the selection of biodigester type such as consideration on durability, reliability, affordability, user-friendliness for construction and operation P2: Describe suitability of different designs in specific site conditions	K1: Criteria to select suitable type of biodigester K2: Different designs of fixed dome biodigester and their suitability in different context
C4.2: Select suitable size of biodigester	P1: Explain pre-requisite for the selection of biodigester size P2: Estimate the quantity of feeding materials (cattle dung) available and gas production P3: Estimate the quantity of gas required based upon end-use applications P4: Select suitable size of biodigester based upon main selection criteria	K1: Criteria to select suitable size of biodigester K2: Calculation of quantity of feeding materials and gas production K3: Various end-use application and gas requirements K4: Different sizes of biodigesters and gas production

Standard 5: 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
C5.1: 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
C5.2: 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
C5.3: 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 constructed in water logging areas and slide-prone areas	K1: The fact that feeding will be difficult and tiresome if biodigester is far from cattle shed K2: Effect of outside temperature on biodigester 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. K5: Potential danger of flooding and cracking of digesters because of water logging and

	P6: Explain the characteristics of best site for constructing biodigesters	ground movements K6: Characteristics of best site for construction of a biodigester
C5.4: Explain steps (sequences) of construction of a fixed dome biodigester	P1: Describe methods of construction of different components of a fixed dome biodigester P2: Describe relative positioning of different components of a fixed dome biodigesters P3: Explain the importance of reference line	K1: Sequence of construction activities K2: Functioning of different components of a fixed dome biodigesters K3: Reference line and its use during construction

Standard 6: Supervise the construction of civil engineering component of a fixed dome biodigester

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

Competency Unit	Performance Criteria	Knowledge and Understanding
C6.1: Supervise the construction of digester	P1: Demonstrate methods for lay out (demarcation) of biodigester P2: Supervise the excavation of pit P3: Prepare mortar P4: Prepare base of the digester and construct foundation P5: Construct digester walls P6: Fix inlet pipes P7: Plaster digester walls P8: Maintain plumb of digester wall P9: Coach and mentor masons to construct digester	K1: Use of drawing, methods of measurement and marking K2: Pit diameter and depth, use of excavation tools K3: Mixing ratio of cement and sand, and methods of preparing mortar of different ratio K4: Methods of leveling, compacting and ramming K5: Methods of use of different construction tools and equipment, masonry skills K6: Proper location of inlet pipes K7: Plastering methods, ratio of cenet and sand on mortar K8: Proper use of plumb-bob K9: Coaching and mentoring techniques
C6.2: Supervise the construction of gas holder and turret	P1: Prepare scaffolding and formworks for dome casting P2: Select and use proper size of templates P3: Prepare mortar and cast gas holder P4: Remove scaffolding and frameworks P5: Carry out inside plastering of gas holder P6: Coach and mentor masons to construct gas holder and turret	K1: Fitting of scaffolding and formworks for casting gas holder K2: Sizes and uses of templates K3: Mixing ratio and methods of preparing mortar of different ratio, methods of casting concrete K4: Safety precautions while removing scaffoldings/frameworks K5: Importance of gas tightness and methods to apply different layers of plasters to ensure leak-proof gas holder K6: Coaching and mentoring techniques

C6.3: Supervise the construction of manhole, outlet/ hydraulic chamber	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 P6: Coach and mentor masons to construct outlet	K1: Methods of constructing manhole K2: Proper use of different construction tools and equipment, masonry skills K3: Plastering techniques, ratio of cement and sand in mortar K4: Proper use of plumb-bob K5: Mixing ratio and methods of preparing mortar of different ratio, methods of casting concrete K6: Coaching and mentoring techniques
C6.4: Supervise the construction of inlet and mixing tank	P1: Construct platform for inlet tank P2: Construct walls of inlet tank P3: Plaster inlet tank P4: Fix mixing device P5: Coach and mentor masons to construct inlet and mixing tank	K1: Use of different construction tools and equipment, methods of doing masonry works K2: Brick and stone masonry woks K3: Plastering techniques, ratio of cement and sand on mortar K4: Methods of fixing vertical and horizontal mixture machines K5: coaching and mentoring skill
C6.5: Supervise the construction of slurry collection and composting pit	P1: Select location of slurry collection and composing pit P2: Decide the size of collection and composing pits P3: Supervise excavation of pits P4: Construct walls and roof of the pits P5: Coach and mentor masons to construct slurry pits	K1: Methods of handling and application of bioslurry K2: General thumb rule to decide the size of slurry pit K3: Selecting pit dimensions, use of excavation tools K4: Use of different construction tools and equipment, masonry skills K5: Coaching and mentoring techniques

Standard 7: Supervise the installation of pipeline, appliances and electro-mechanical components

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

Competency Unit	Performance Criteria	Knowledge and Understanding
C7.1: Supervise the installation of pipeline	P1: Describe quality standard of pipes and fittings P2: Select correct size of pipes and fitting P3: Select best alignment for pipe laying P4: Join pipes using correct fitting and sealing agent P5: Protect pipeline against possible damage P6: Coach and mentor masons to install pipelines	K1: Quality standards of pipes and fittings K2: Selection of pipe size based upon distance and flow of biogas K3: Effect of longer pipe on cost as well as risk of biogas leakage K4: Plumbing techniques; fittings and sealing agents such as Teflon tape K5: Methods to protect pipeline against possible damage K6: Coaching and mentoring techniques
C7.2: Supervise the installation of appliances	P1: Name different types of biogas appliances and end use applications P2: Describe quality standards of appliances P3: Fix biogas stoves, lamps and other appliances as per users' need P4: Supervisor the installation of gas flow meter, temperature gauge and pressure gauge P5: Coach and mentor technicians	K1: Types of biogas appliances such as stoves, lamps, water heaters, rice-cookers, generators K2: Quality standards of biogas appliances K3: Methods of fitting appliances, plumbing skills K4: Plumbing skill understanding of functioning of gas flow meter, temperature gauge and pressure gauge K5: Coaching and mentoring skill

C7.3: Supervise the fabrication/ manufacturing and preparation of filtration systems	P1: Describe quality standards of fabrication/manufacturing of filter systems P2: Supervise the fabrication of CO_2 scrubber P3: Supervise the fabrication of H_2S remover P4: Supervise the fabrication of moisture removal	K1: Quality standards of biogas purification system K2: Plumbing skill, fixing and functioning of CO_2 scrubber K3: Plumbing skill, fixing and functioning of H_2S remover K4: Plumbing skill, fixing and functioning of moisture removal
C7.4: Supervise the installation of gas filtration/purification system	P1: Describe quality standards of installation of filter system P2: Install CO_2 scrubber (for bigger plants of more than 100 cum) P3: Install H_2S remover P4: Install moisture removal P5: Coach and mentor masons to install filters	K1: Quality standards of biogas purification system K2: Plumbing techniques, functioning of CO_2 scrubber and safe disposal practices of carbonated water K3: Plumbing techniques, functioning of H_2S remover K4: Plumbing techniques, functioning of moisture removal K6: Coaching and mentoring techniques
C7.5: Supervise the installation of pump and/or generator	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 P6: Coach and mentor masons to install pumps/generators	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 techniques, working of biogas operated engines K6: Coaching and mentoring techniques

Standard 8: Ensure effective operation and timely maintenance of the installed biodigesters

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
C8.1: Describe routine operation activities for trouble-free functioning of biodigester	P1: Prescribe correct quantity of feeding P2: Describe the effect of under-feeding and over-feeding P3: Demonstrate efficient use of different appliances such as water drain, main valve, gas taps P4: Perform leakage testing P5: Explain dos and don'ts dos for effective functioning of biodigesters	K1: Quantity of feeding/biodigester loading rate K2: Effects of underfeeding and overfeeding, change in HRT K3: Operation of different appliances, working principle of appliances K4: Leakage testing methods and protocols, use of soap-water solution, colour smoke etc. K5: dos and don'ts dos for effective functioning of biodigesters
C8.2: Conduct minor repair and maintenance works	P1: Demonstrate changing of washers P2: Perform greasing/oiling of gas taps P3: Perform minor repair of appliances P4: Perform repair of leaked pipeline	K1: Use of repair and maintenance tools K2: Greasing techniques K3: Working of appliances K4: Use of plumbing tools, and sealing agents
C8.3: Identify potential problems and likely solutions	P1: Demonstrate the use of pH meter, pressure meter, foot pump, gas flow meter to identify potential problems P2: Carry out pressure testing to detect biogas leakages P3: Inspect the colour of bioslurry, water dung ratio, flow pattern and odour of bioslurry to asses potential problems	K1: Functioning and use of testing tools and equipment K2: Pressure testing methods and protocols K3: Changes in slurry during the process of biogas formation.
C8.4: Explain methods for optimum utilization of biogas and bioslurry	P1: Describe different uses of biogas and biogas appliances P2: Identify potentials for diversification of biogas end use applications	K1: Different end-use applications and biogas consumption rates of different appliances K2: Various end-use applications of biogas

	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	K3: 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
C8.5: Instruct users for effective operation and maintenance of biodigester	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	K1: Common/potential problems and likely solutions K2: Facilitation techniques, effective operation activities K3: Facilitation techniques, repair and maintenance methods
C8.6: Plan, conduct and facilitate users' training	P1: Organize, conduct and facilitate user's training on operation and maintenance P2: Demonstrate effective use of biogas P3: Demonstrate methods of using bioslurry	K1: Training and facilitation techniques, planning and organizing adult training K2: Methods of optimal use of biogas K3: Methods of bioslurry application and handling
C8.7: Ensure sustainable benefits from biodigester	P1: Provide warranty to ensure long term functioning of biodigester P2: Perform timely after-sale services P3: Provide user's manual	K1: Guarantee provisions and criteria K2: Need of effective after-sale-services K1: Importance of user's manual

Standard 9: Perform technology promotion and quality assurance tasks

Overview: This competency standard ensures that the participants are able to apply promotion and marketing techniques; and enforce quality assurance mechanisms for ensuring quality product.

Competency Unit	Performance Criteria	Knowledge and Understanding
C9.1: Promote biodigester technology in Pakistan	P1: Identify and explain unique-selling points for marketing biogas technology in Pakistan P2: Adopt different tools and techniques for the promotion of biogas technology	K1: Promotion and marketing of new technology K2: Promotion and marketing tools and their application
C9.2: Describe the importance of quality assurance	P1: Describe the definition of quality assurance while constructing biodigester P2: Explain why quality in needed while construction 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
C9.3: Ensure that the masons/technicians practice quality norms during construction	P1: Explain quality standards to be complied while construction P2: Supervise the work of mason to comply with set quality standards while constructing biodigester	K1: Quality standards and norms K2: Methods to comply with quality standards and norms
C9.4: Describe the roles and responsibilities of a technical supervisor	P1: Tell roles and responsibilities of a biogas technical supervisor while construction P2: Describe what happens if a biogas technical supervisor does not fulfil his/her responsibilities	K1: Internalization of roles and responsibilities of a biogas technician K2: Effect of sub-standard works on quality of end-product and functioning of a biodigester
C9.5: Ensure that occupational health and safety measures are practiced properly	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: Safety gears during construction and their uses K2: Construction tools and equipment and their safe uses K3: General safety measures at work

C9.6: Conduct routine quality control visits and manage data properly	P1: Fill quality control forms and formats P2: Ensure proper management of data and information P3: Coach and mentor the masons/technicians as and when needed	K1: Different forms and formats for quality control K2: Data collection, data handling and data management techniques K3: Coaching and mentoring techniques

List of Tools, Machinery & Equipment

Name of Trade	Training of Biodigester Technical Supervisors to supervise the construction of Fixed Dome Biodigesters for Running Pumps
Duration	Four weeks (33 days or 264 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 – for a group of 25 participants	
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/shoes	25
45.	Gloves	25
46.	Rain coats	25
	Biogas Related Appliances/Equipment	
47.	Pressure gauge	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 Technical Supervisors to supervise the construction of Fixed Dome Biodigesters for Running Pumps
Duration	Four weeks (33 days or 264 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.	Bag	25
17.	White paper (A4)	1 rim
	Construction Materials and appliances for 20 m^3 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.	Acrylic emulsion paint	
26.	Scaffolding (if earthen mould is not used)	
27.	PVC/GI pipe and fittings as per site condition	
28.	Biogas filters (CO_2 scrubber, H_2S remover, moisture remover)	
29.	Biogas appliances (as per sit condition and users' need)	
30.	Control valves – as per site condition	
31.	Main gas pipe – GI 1.5" diameter, 1 m long with reducing elbow	
32.	Teflon tape	
33.	Pressure gauge	
34.	Gas flow meter	
35.	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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