UNDERWATER WELDING TRAINING SKILLS FOR YOUTHS' SELF-RELIANCE IN AKWA IBOM STATE

BY

UKPONG, PAULINUS HAPPY-DAY
HEAD OF DEPARTMENT
DEPARTMENT OF FABRICATION AND WELDING
GOVERNMENT TECHNICAL COLLEGE, ABAK
AKWA IBOM STATE, NIGERIA.

ABSTRACT

This research explored underwater welding training skills for youths' self-reliance in Akwa Ibom State. The focus of the study was to determine the wet underwater welding training skills and dry underwater welding training skills needed by youth in Akwa Ibom State for self-reliance. The study adopted descriptive survey research design. The population of the study was made up of 96 fabrication/welding teachers and 42 underwater welding technicians making the total of 138 staff from both the oil and gas industries and technical colleges in Akwa Ibom State. The sample size for the study was 69; comprising 48 fabrication/welding teachers and 21 underwater welding technicians representing 50% which were selected through simple random technique. Data was collected through the instrument titled Underwater Welding Training Skills for Youth Self-Reliance Questionnaire (UWTSYSQ). The instrument was validated by three lecturers in the Faculty of Educations, University of Uyo and was adjudged reliable based on the reliability index of 0.84 for fabrication and welding teachers and 0.86 for underwater welding technicians. Mean and independent t-test statistics were used to analyze the data obtained. The findings from the study reveal that there are no significant differences between the responses of fabrication/welding teachers in Technical College and underwater welding technicians in Akwa Ibom State on wet underwater welding skills and dry underwater welding skills. In view of the findings from this study, recommendations were made among others that the National Board for Technical Education should develop curriculum that suit the needs of the environment where the institution is sited. Also, private institutions in Akwa Ibom State should offer courses like underwater welding since underwater welding is a crucial aspect of oil and gas exploration most especially when it is explored off-shore.

Keywords: Underwater Welding, Training Skill, Youth Self-Reliance.

Background of the Study

Underwater welding is a process whereby metals are melted and joined together inside water to either repair a structure or create a new structure. Underwater welding came into practice in 1939 (Khanna, 2004). Although a large number of techniques are available for welding in atmosphere, many of these techniques are not suitable for offshore and marine applications in which the presence of water is of major concern. In this regard, it is relevant to note that the majority of offshore repairing and surfacing works are executed at a relatively shallow depth (3m) in the region intermittently covered by the water known as splash zone. Though numerically, most ship repairs and welding jobs are executed at shallow depths, the most technologically challenging task is repair at greater depths, especially involving pipelines and repair of accidental failure. In recent years, the number of offshore structures including oil drilling rigs, pipelines, platforms are being installed and maintained significantly by underwater welding. According to Joshi (2004), some of these structures will experience failure of their elements during normal usage and during unpredicted occurrences like storms and collisions. Any repair method in the foregoing situation will require the application of underwater welding. Keats (2009) noted that underwater welding provided a number of benefits. Firstly, there is no need to pull the structure out from underwater to perform work. In addition, many structures like oil rigs and ship hulls may be accidentally damaged at sea, necessitating the need for immediate work below the surface. The poor quality and difficulty in the process of welding underwater in the past, made welding in the wet environment to be used primarily for emergency repairs in shallow depth. With more experience and the advent of special welding rods together with the persistence of some ambitious individuals and companies, improved results were achieved, thus making wet welding a common occurrence. The advantages of underwater welding are largely of an economic nature, because underwater welding for marine maintenance and repair job bypass the need to pull the structure out of the sea and save valuable time and dry docking costs (Cary and Helzer, 2005). The authors noted that it is an important technique for emergency repairs which allow the damaged structure to be safely transported to dock for permanent repair or scrapping. Underwater welding can be classified as: wet underwater welding and dry underwater welding.

Wet underwater welding is performed inside water and directly exposed to the wet environment. A special electrode (filler material) is used and welding is performed manually just as one does in conventional welding practices. The increased freedom of movement by the underwater welder makes wet underwater welding the most effective, efficient and economical method. Welding power supply is located on the surface with connections to the underwater welder via cables and hoses. The underwater welder instructs the surface operator to make or break the contact as required during the operation. The contact is only closed during welding operation and opened after wielding, particularly when changing electrodes. Wet underwater welding directly exposes the underwater welder and electrode to the water and surrounding elements. Underwater welders usually use about 300 – 400 amperes of direct current (d.c) to melt electrodes. Wet underwater welding employs different methods of welding, but the most commonly used wet underwater welding technique is Shielded Metal Arc Welding (SMAW) or Direct Current Arc Welding (DCAW). The electric arc heats the work piece and the welding rod, the molten metal is transferred through the gas bubbles around the arc. The gas bubbles are partly formed from decomposition of the flux coating on the electrode but it is usually contaminated to some extent by stream. Current flow reduces transfer of metal droplets from the electrode to the work piece and enables positional welding by a skilled operator (underwater welder). Slag deposition on the weld surface helps to slow down the rate of cooling, but rapid cooling is one of the biggest problems in producing a quality weld.

Wet underwater welding indicates that welding is performed underwater, directly exposed to the wet environment as shown in Figure 1. A special electrode is used and welding is carried out manually just as one does in open air welding. The increased freedom of movement makes wet welding the most effective, efficient and economical method. Welding power supply is located on the surface with connection to the underwater welder via cables ad hoses (Joshi, 2004).

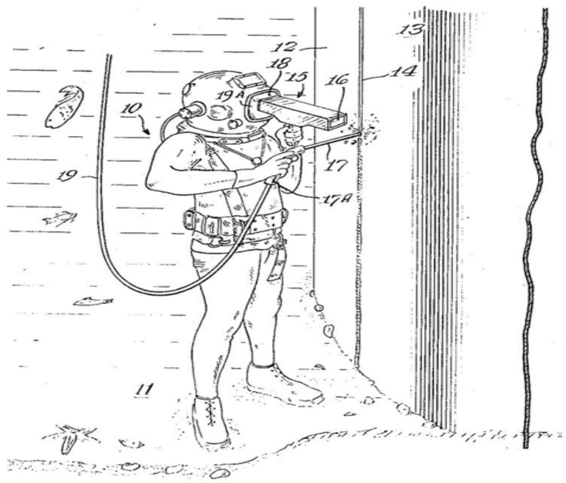

Figure 1: Wet underwater welding
Source: American Wielding Society (2001)

The power source should be a direct current machine rated at 300 or 400 amperes. Motor generators welding machines are most often used for wet underwater welding. The welding machine must be grounded to the ship hull. The welding current must include a positive type switch, usually a knife switch operated on the surface and commanded by welder/diver. The knife switch in the electrode circuit must be capable of breaking the full welding current and is used for safety reasons. The welding power should be connected to the electrode holder only during welding (Joshi, 2004).

Joshi (2004) contended that direct current with electrode negative (straight polarity) is used in the process during underwater welding work. Special welding electrode holders with extra insulation against the water are used. The underwater welding electrode holder utilizes a twist type head for gripping the electrode. It accommodates two sizes of electrodes. The electrode types used conforms to AWSE 6013 classification. The electrodes must be water proofed. All connections must be electrically sound and continuous, thoroughly insulated to prevent leakage current.

Keats (2009) confirmed that underwater wet welding has been employed for many years now, but has commercially been restricted to conventional Manual Metal Arc Welding (MMAW) techniques. The typical problems associated with underwater Manual Metal Arc Welding (MMAW) fall into two categories, mechanical/metallurgical quality and skill and ability. It was with both issues in mind that a new methodology of Manual Metal Arc Welding (MMAW) was devised. Underwater wet welding, accepted as low cost, practical alternative to dry or hyperbaric welding can however, suffer from quality issues mainly due to the rapid cooling (Keats, 2004). It is well appreciated that the skills and abilities necessary to execute high quality, conventional Manual Metal Arc Welding (MMAW) welds are extremely high, therefore labour and training are significant factors (Kraji, Kozuh, Garasic and Dorn, 2003).

Joshi (2004) explained that wet underwater welding has now been widely used for many years in the repairs of offshore platforms. The benefits of wet welding are;

1. The versatility and low cost of wet welding makes this method highly desirable.
2. It is less costly compared to dry welding
3. The welder can reach portions of offshore structures that could not be welded using other methods.
4. No enclosures are needed, hence no time, money and material is wasted in the production of enclosures.
5. Other benefits include the speed with which the operation is carried out.

Although wet welding is widely used for underwater fabrication works, it suffers from the following drawbacks;

1. There is rapid quenching of the weld metal by the surrounding water. Although quenching increases the tensile strength of the weld, it decreases the ductility and impact strength of the weldment and increases the porosity and hardness.
2. Large amount of hydrogen is present in the weld region, resulting from the dissolution of the water vapour in the arc region. The hydrogen dissolves in the heat affected zone and the weld metal, which causes embrittlement, cracks and microscopic fissures. Cracks can grow and may result in catastrophic failure of the structure.
3. Another disadvantage is poor visibility, which makes the diver/welder sometimes unable to weld properly.

The American welding societies on underwater welding specification, (AWS 1999) describes the wet welding process as one in which the diver/welder and the welding arc are exposed to the water without any physical barrier. This particular standard was prepared in response to the needs for a specification that would allow users of underwater welding to conveniently specify and produce welds to a predictable performance level.

The principles of operation of wet welding, according to Joshi (2004) are that, the work to be welded is connected to one side of an electric circuit and a metal electrode to the other side. These two parts of the circuit are brought together and then separated slightly. The electric current jumps the gap and causes a sustained arc, which melts the bare metal, forming a weld pool. At the same time, the tip of electrode melts and the metal droplets are projected into the weld pool. During this operation, the flux covering the electrode melts to provide a shielding gas, which is used to stabilize the arc column and shield the transfer metal; hence, the name Shielded Metal Arc Welding (SMAW). The arc burns in a cavity formed inside the flux covering, which is designed to burn slower than the metal barrel of the electrode (Joshi, 2004; Keats, 2004).

Keats (2004) stressed that Manual Metal Arc Welding (MMAW) or Shield Metal Arc Welding (SMAW) is still one of the most important fusion welding processes, for both surface and underwater welding in today's construction industries. For underwater welding, the arc does not behave as in air. The activity of the gas bubbles being particular important, as this tends to create a rather stable condition as compared with surface welding, together with a same-what more confusing weld puddle, which must be mastered by the underwater welder before successful welding can take place. Keats (2004) maintained that even in poor visibility, all the diver/welder need do is to exert a slight downward pressure on the electrode to maintain a constant feed rate, which keeps the flux chipping and burning away without the need for any arc length control as such.

In dry underwater welding, a dry chamber is created near the area to be welded and the welder does the job by staying inside the chamber. Gas Tungsten Arc Welding (GTAW) is the only suitable method of welding employed for dry underwater welding. The sealed chamber around the structure to be welded is filled with a gas (commonly helium containing 0.5 bar of oxygen) at the prevailing pressure. The habitat is sealed into the pipeline and filled with a breathable mixture of helium and oxygen, at or slightly above the ambient pressure at which the welding is to take place. This method produces high-quality weld joints that meet x-ray and code requirements. The welding is done in the dry but at the hydrostatic pressure of the sea water surrounding the habitat. Special control techniques have been applied which allowed welding down to about 2,500m simulate.

Hyperbolic welding (dry welding) is carried out in a chamber sealed around the structure to be welded. The chamber is filled with a gas (commonly helium containing 0.5 bar of oxygen) at the prevailing pressure. The habitat is sealed onto the pipeline and filled with a breathable mixture of helium and oxygen, at or slightly above the ambient pressure at which the welding is to take place as shown in Figure 10. This method produces high quality weld joints that meet X-ray and code requirements. The Gas Tungsten Arc Welding (GTAW) process is employed for this process (Joshi, 2004). The area under the floor of the habitat is open to water. Thus, the welding is done in the dry but at the hydrostatic pressure of the sea water surrounding the habitat.

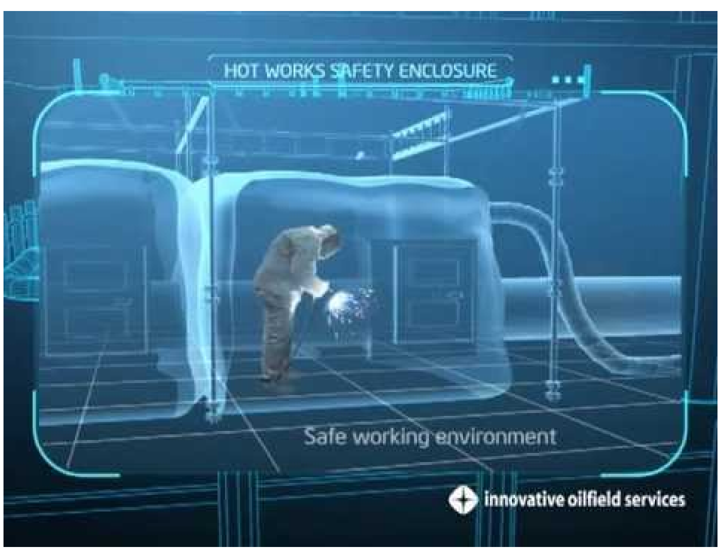

Figure 10: An illustration showing a chamber of dry underwater wielding
Source: Dantas, Lima II, and Bracarense (2005)

Joshi, (2004) discovered the risk to the welder/diver of electric shock. Joshi opined that precautions include achieving adequate electrical insulation of the welding equipment, shutting off the electricity supply immediately the arc is extinguished and limiting the open-circuit voltage of Manual Metal Arc Welding (MMAW) or Shielded Metal Arc Welding (SMAW) sets. Secondly, hydrogen and oxygen are produced by the arc in wet welding. Joshi (2004) stressed that precautions must be taken to avoid the build-up of pockets of gas, which are potentially explosive. The other main area of risk is to the life or health of the welder/diver from nitrogen introduced into the blood stream during exposure to air at increased pressure. Precautions include the provision of an emergency air or gas supply, stand by divers, and decompression chambers to avoid nitrogen narosis following rapid surfacing after saturation diving.

The advantages of dry welding, according to Joshi (2004), are welding is performed in a chamber, immune to ocean current and marine animals. The warm, dry habitat is well illuminated and has its own environmental control system. Dry underwater welding has ability to produce welds of quality comparable to open air welds because water is no longer present to quench the weld and hydrogen (H_2) level is much lower than wet welding. Also, joint preparation, pipe alignment, Non-destructive test (NDT) inspection are monitored visually; Non-Destructive Testing in also facilitated by the dry habitat environment. The disadvantage of dry underwater welding is that the habitat welding requires large quantities of complex equipment and much support equipment on the surface. The chamber is extremely complex and expensive.

Majunida (2006) maintained that underwater welding in a dry environment is made possible by encompassing the area to be welder with physical barrier (weld chamber) that excludes water. The weld chamber is designed and custom built to accommodate braces and other structural members whose centre lines may intersect at or near the area that is to be welded. The chamber is usually built of steel, but plywood, rubberized canvas or any other suitable material can be used. Size and configuration of the chamber are determined by dimensions and geometry of the area that must be encompassed and the member of welders that will be working in the chamber at the same time (Majunida, 2006). Water is displaced from within the chamber by air or a suitable gas mixture, depending upon water depth and pressure at the work site. Buoyancy of the chamber is off-set by ballast, by mechanical connections and chamber to the structure, or by a combination of both.

Dry welding requires a pressurized enclosure having controlled atmosphere. Weld metal is not in direct contact with water. Advantages of dry water welding are; improvement in suitability of welding operation, reduced hydrogen problem, lower quench rate of the weld and base metal and restoration of weld strength and ductility (Oates, 1996). Dry underwater welding may be carried out under high pressure which consist of preparing an enclosure to be filled with gas (helium) under high pressure (hyperbaric) to push water back and have the welder, filled with breathing mask and other protective equipment (Oates, 1996). Limitations of hyperbaric welding are the practical difficulties in sealing the chamber and increase in pressure as weld depth increases, leading to problems which affect both the weld chemistry and microstructures.

Keats (2004) contended that manual metal arc welding (MMAW) is still one of the most important fusion welding processes, for both surface and underwater welding in today's construction industries. American terminology refers to it as Shielded Metal Arc Welding (SMAW).

Purpose of the Study

The study was set to achieve the following objectives:

1. Determine the wet underwater welding training skills needs of youth for self-reliance in Akwa Ibom State.
2. Determine the dry underwater training skills needs of youth for self-reliance in Akwa Ibom State.

Research Questions

The following research questions guided the study.

1. What are the wet underwater welding skills needed by youth for self-reliance in Akwa Ibom State?
2. What are the dry underwater welding skills needed by youth for self-reliance in Akwa Ibom State?

Hypotheses

In line with the slated objectives and research questions, the following null hypotheses were formulated for the study:

Ho_1: There is no significant difference between the responses of fabrication/welding teachers in Technical Colleges and underwater welding technicians on wet underwater welding skills of youth for self-reliance in Akwa Ibom State.

Ho_2: There is no significant difference between the responses of fabrication/welding teachers in Technical Colleges and underwater welding technicians on dry underwater welding skills of youth for self-reliance in Akwa Ibom State.

Methodology

The study adopted the use of descriptive survey research design using questionnaire. Ndiyo (2005) emphasized that a study of this nature where large samples are involved is better carried out with a descriptive survey design. Ojo (2001) state that descriptive survey design is a design technique for obtaining data from people through the use of questionnaire, observation and interview. According to Osuala (2005), the descriptive design is the design suitable for the collection of data based on the opinion of people. The population of the study was made up of 42 underwater welding technicians and 96 fabrication and welding teachers, making the total of 138 staff from both the Oil and Gas Industries and Technical Colleges in Akwa Ibom State. The sample size for the study was 69; comprising 21 underwater welding technicians and 48 fabrication and welding teachers representing 50% which were selected through simple random sampling. Data was collected through the instrument titled: Underwater Welding Training Skills for Youth Self-reliance Questionnaire (UWTSYSQ. This instrument was designed by the researcher and validated by three validates in the faculty of Education, University of Uyo and was adjusted reliable based on the reliability index of 0.84 for fabrication/welding teachers and 0.86 for underwater welding technicians. The researcher ensured accurate distribution and collection of the filled questionnaire by means of personal administration of the instrument to the respondents in their various offices. The descriptive statistics of mean and standard deviation was used to answer research questions while the hypotheses raised were tested using independent t-test at 0.05 level of significance.

Data Analysis Result and Discussion

The following tables show the summary of the analysis carried out based on the data collected using mean, standard deviation and independent t-test.

Research Question 1

What are the wet underwater welding skills needed by youths for self-reliance in Akwa Ibom State?

Table 1: Mean and standard deviation analysis of wet underwater welding skills needed by youths for self-reliance in Akwa Ibom State

N = 69 $n_1 = 48$ $n_2 = 21$

S/N	Item	Fabrication/ Welding Teachers		Underwater Welding Technicians		Difference in mean	Remark
		$\overline{X}_1$	SD	$\overline{X}_2$	SD		
1	Selecting correct amperage.	3.81	0.60	3.18	1.13	0.63	**
2	Selecting the proper electrode.	3.69	0.72	3.07	0.97	0.60	**
3	Inserting the electrode into the tong.	3.81	0.57	3.18	0.93	0.63	**
4	Striking an arc.	3.65	0.77	3.29	0.87	0.36	**

5	Moving electrode normally for bead formation	2.58	1.00	3.04	0.77	-0.46	*
6	Maintaining the right lead angle.	2.44	0.97	3.16	0.97	-0.72	*
7	Dragging electrode across work.	2.65	0.98	3.40	0.85	-0.75	*
8	Oscillating electrode to change slope angle.	2.56	1.23	3.21	0.79	-0.65	*
9	Controlling the solidification rate of the weld puddle.	1.86	0.97	3.23	0.82	-1.37	*
10	Checking the cooling rate of the weld puddle.	1.95	0.97	3.32	0.76	-1.37	*

Key: * = needed; ** = not needed; N = total number of sample size; n_1 = number of fabrication/welding teachers n_2 = number of underwater welding technicians, $\bar{x}_1$ mean for fabrication/welding teachers and $\bar{x}_2$ = mean for underwater welding technicians.

Data analysis in Table 1 shows that the differences in mean for the responses of fabrication and underwater welding teachers and welding technicians for item number 1 to 4 are positive values; while those for item number 5 to 10 are negative values. The results imply that the youths from technical colleges are lacking in those skills with negative differences in mean and therefore need training in these areas whereas those skills with positive differences in mean are the ones the youths need little or no training for self-reliance in Akwa Ibom State.

Research Question 2

What are the dry underwater welding skills needed by youths for self-reliance in Akwa Ibom State?

Table 2: Mean and standard deviation analysis of dry underwater welding skills needed by youths for self-reliance in Akwa Ibom State

N = 89 $n_1 = 48$ $n_2 = 21$

S/N	Item	Fabrication/ Welding	Underwater Welding Technicians	Difference in mean	Remark

		Teachers					
		$\overline{X}_1$	SD	$\overline{X}_2$	SD		
1	Checking electrical insulation of welding equipments.	2.77	1.08	2.90	0.76	-0.13	*
2	Cleaning metal joints for welding properly.	3.69	0.70	2.99	0.85	0.70	**
3	Selecting correct electrode size.	3.81	0.55	2.90	0.99	0.91	**
4	Arc welding different forms of joints.	3.72	0.68	3.12	0.93	0.60	**
5	Moving electrode at the needed speed along the line.	2.19	1.03	3.34	0.63	-1.15	*
6	Detecting the correct pressure to weld.	2.86	1.05	3.01	0.84	-0.15	*
7	Hard facing with arc.	2.14	0.77	3.13	0.96	-0.99	*
8	Running bead with filler rod.	2.14	0.97	3.18	0.86	-1.04	*
9	Lap welding with thick steel.	2.01	0.99	3.06	0.89	-1.05	*
10	Keeping proper height of the deposited metal approximately 6mm above the work piece.	2.17	0.82	3.17	0.86	-1.00	*

Key: * = needed; ** = not needed; N = total number of sample size; n_1 = number of fabrication/welding teachers, n_2 = number of underwater welding technicians, $\overline{x}_1$ mean for fabrication/welding teachers and $\overline{x}_2$ = mean for underwater welding technicians.

Data analysis in Table 2 indicates that the difference in mean values between the respondents of fabrication and welding teachers and underwater welding technicians for item number 1, 5, 6, 7, 8, 9 and 10 are -0.13, -1.15, -0.15, -0.99, -1.04, -1.05, -1.00 respectively; while those for item number 2, 3 and 4 are 0.70, 0.91 and 0.60 respectively. The results indicate that the youths from technical colleges are lacking in those skills with negative differences in mean and therefore need training in these areas while the skills with positive differences in mean are the ones the youths from technical colleges need little or no training for youths' self-reliance in Akwa Ibom State.

Hypothesis 1

There is no significant difference between the responses of fabrication and welding teachers in Technical Colleges and underwater welding technicians in oil and gas industries on the wet underwater welding skills for youths' self-reliance in Akwa Ibom State.

Table 3: Independent t-test analysis of difference between the responses of fabrication and welding teachers and underwater welding technicians on wet underwater welding skills

N = 89

Variable	n	$\overline{X}$	SD	df	tcal	Tcri	Decision
Fabrication/welding teachers	48	29.00	8.78				
				214	-2.44*	1.96	Reject H_{01}
Underwater welding technician	21	32.10	8.86				

* = significant at 0.05 alpha level

Data analysis in Table 3 shows that the calculated t-value of -2.44 is greater than the critical t-value of 1.96 at df of 214 and 0.05 level of significance. Here, the null hypothesis is rejected. Therefore, there is a significant difference between the responses of fabrication and welding teachers in technical colleges and underwater welding technicians in the oil and gas industries on the wet underwater welding skills for youths' self-reliance in Akwa Ibom State. The negative independent t-test value indicates that the youths need a lot of training on the wet underwater welding skills for their self-reliance in Akwa Ibom State.

Hypothesis 2

There is no significant difference between the responses of fabrication and underwater welding teachers in Technical Colleges and welding technicians in oil and gas industries on the dry underwater welding skills for youths' self-reliance in Akwa Ibom State.

Table 4: Independent t-test analysis of difference between the responses of fabrication and welding teachers and underwater welding technicians on dry underwater welding skills

N = 89

Variable	N	$\overline{X}$	SD	df	tcal	Tcri	Decision
Fabrication/welding teachers	48	27.50	8.84				
				214	-2.62*	1.96	Reject H_{02}

Underwater welding technician	21	30.80	8.57

* = significant at 0.05 alpha level

Data analysis in Table 4 revels that the calculated t-value of -2.62 is greater than the calculated t-value of 1.96 at df of 214 and 0.05 level of significance. Hence, the null hypothesis is rejected. Therefore, there is a significant difference between the responses of fabrication and welding teachers in technical colleges and underwater welding technicians in oil and gas industries on the dry underwater welding skills for youths' self-reliance in Akwa Ibom State. The negative independent t-test value implies that the youths need enough training on dry underwater welding skills for their self-reliance in Akwa Ibom State.

Discussion of Findings

The result of hypothesis one on table 3 revealed that, there is a significant difference between the responses of fabrication and welding teachers in technical colleges and underwater welding technicians in oil and gas industries on the wet underwater welding skills for youths' self-reliance in Akwa Ibom State. The negative t-test value indicates that the youths need a lot of training on the wet underwater welding skills for self-reliance in Akwa Ibom State. The findings of the study go in line with that of Keats (2004) that Manual Meal Arc Welding (MMAW) or Shield Metal Arc Welding (SMAW) is still one of the most important fusion welding processes for both surface and underwater welding in today's construction industries. Keats (2004) maintained that even in poor visibility, all the diver/welder need do is to exert a slight downward pressure on the electrode to maintain a constant feed rate, which keeps the flux chipping and burning away without the need for any arc length control as such. In support of the findings of the study, Joshi (2004) maintained that in wet underwater welding, a special electrode is used and welding is carried out manually just as one does in open air welding. The increased freedom of movement makes wet welding the most effective, efficient and economical method. The results of data analysis and evidence from review of related literature disclosed that the youths need training in different areas of wet underwater welding to qualify them for self-reliance in Akwa Ibom State.

Analysis of hypothesis two on table 4 showed that, there is a significant difference between the responses of fabrication and welding teachers in technical colleges and underwater welding technicians in oil and gas industries on the dry underwater welding skills for youths' self-reliance in Akwa Ibom State. The negative t-test value implies that the youths need enough training on dry underwater welding skills for their self-reliance in Akwa Ibom State. The findings of the study is supported by the work of Oates (1996) that dry underwater welding be carried out under high pressure which consist of preparing an enclosure to be filled with gas (helium) under high pressure (hyperbaric) to push water back and have the welder, filled with breathing mask and other protective equipment. Oates (1996) noted that the limitations of hyperbaric welding are the practical difficulties in sealing the chamber and increase in pressure as weld depth increases, leading to problems which affect both the weld chemistry and microstructures. Majunidar (2006) supported that underwater welding in a dry environment is made possible by encompassing the area to be welded with physical barriers. The results of data analysis and evidence from review of related literature indicated that youths need training in various areas of dry underwater welding to qualify them for self-reliance in Akwa Ibom State.

Conclusion

In view of the data analysed and the findings made, it can be concluded that significant difference exist between the responses of fabrication/welding teachers in technical colleges and underwater welding technicians in the oil and gas industries on the wet underwater welding skills and dry underwater welding skills for youths self-reliance in Akwa Ibom State. The findings indicate that the youths need adequate training in the foregoing areas of underwater training.

Recommendations

Based on the findings of the study, the following recommendations are made:

1. Proprietors of private institutions should include underwater welding as a course in their institutions especially those sited in Akwa Ibom State.
2. The fabrication and welding teachers should be properly trained by the Federal Government through workshops and seminars on the practical skills expected by youths since there are significant differences between their responses and those of underwater welding technicians on wet underwater welding skills and dry underwater welding skills.
3. The curriculum developers should modify the curriculum of mechanical engineering in all Universities and Polytechnics to include at least introductory aspect of underwater welding.

REFERENCES

American Welding Society (AWS) (1999). *Underwater welding specification*. Miami; Florida AWS.

American Welding Society, (2001). *Welding science and technology: Wielding Handbook,* Volume 1, 9th edition. Miami, USA, AWS. pp 452-482.

Cary, H. B. and Helzer, S. C. (2005). *Modern welding Technology*. Upper Saddle River, New Jersey: Pearson Education pp. 677 – 681.

Dantas, C. M., Lima II, E. J. and Bracarense, A. Q. (2005). Development of an instrumented gripper for robotic shielded metal arc welding. *Mechanical Engineering Journal,* 89(5): 108-114.

Joshi, A. M. (2004). *Underwater welding*. Mechanical Engineering Department, Indian Institute of Technology.

Keats, D. J. (2004). *Underwater welding: A welders mate, Leicester*. UK: Matador/Troubador Publishing.

Keats, D. J. (2004). *Underwater welding: A welders mate, Leicester*. UK: Matador/Troubador Publishing.

Keats, D. J. (2009). Underwater wet welding made simple: Benefits of hammer lead wet-spot welding process. *International Journal of the society for Underwater Technology*, 28 (3): 115-127.

Khanna, O. P. (2004). *A textbook of welding technology*. India: Dhanphat Rai Publications Ltd.

Kraji, S., Kozuh, Z., Goraic, I. and Dorn, L. (2003). Influence of the water environment on the parameters in underwater wet welding and cutting. *International Journal of the Society for Underwater Wielding Technology,* 55(2): 97-99.

Majunida, J. D. (2006). Underwater Welding present status future slope. *Journal of Naval Architecture and Marine Engineering*; 3:39-48.

Ndiyo, N. (2005). *Fundamental of research behavioural sciences and humanities*. Calabar: Wusen Publishers.

Oates, W. A (1996). *Welding handbook (vol. 3)*. Miami, Florida: USA, American Welding Society.

Ojo, J. E. (2001) *Research method and statistics in educational and social science*. Lagos: Jaya Press Ltd.

Osuala, E. C. (2005) *Introduction to research method*. Enugu: Chaston agency Ltd.