Design of Remote RW equipment for a DUPIC Bundle Fabrication

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1. Introduction

The design of remote welding equipment for a DUPIC bundle fabrication was undertaken to establish the optimum welding processes in a hot cell environment. An initial investigation for a hands-on fabrication outside the hot cell was performed, and the constraints of the welding equipment for the hot cell conditions were considered[1]. Generally a gas tungsten arc welding (GTAW), laser beam welding (LBW), friction welding (FW), and resistance welding (RW) process were assessed as candidates for this application. Preliminary welding performances to improve the RW process were also examined. The RW process was determined to be the best in a hot cell environment for joining an end plate to end caps. The greatest advantage of the RW would be a qualified process for an overlapping plate welding for which there is extensive production experience.

This paper presents an outline of the developed RW equipment for a DUPIC bundle fabrication and reviews the conceptual design of a remote RW welder by using a manipulator. The design of RW equipment by using the 3D drawing method was also investigated.

2. Welding Equipment and Results

2.1 Equipment Specifications and Remote Hot Cell operation

For a DUPIC bundle fabrication, a remote welder was designed by using the RW process as shown in Fig. 1.

Size	846(W)x1273(L)x1600(H) [mm]			
Welding Method	Resistance Welding (Servo motor, PLC programmer and controller			
Weld Cycle	Squeeze Cycle: 30 Hold Cycle: 30 Weld Cycle: 2			
Power Supply	Rotation	Max. Torque (Nm)		1.88
		Voltage Constant (Volts/rad/s)		14.66
		Torque Constant(Nm/ Amp DC)		0.139
		Max Bus Voltage(Volts DC)		340
	Linear	Continuous Power	Regular Power(W)	400
			Regular Torque(Nm)	1.3
		Total Capacity (Kv A)		2.9
		Regular Current (A)		2.3
		Max. Current (A)		6.9
		Encoder, Servo Motor :131072P/rev		
Main Head Pressure	64 / 72 PSI			
Diaphragm P	64 / 72 PSI			
Weld Contact Pressure	50 PSI			
Air Pressure	6-7 (bar)			

Fig 1. Technical specifications of the remote welding equipment.

Remote welding system will be developed by adopting a head torch in order to achieve a spot weld metal between an end plate and a end cap by using a manipulator, as shown in Fig. 2. A remote welding system for a hot cell environment consists of an RW multi-pin welder, a manipulator and a controller. The main head of the welding equipment will use the multi-pulse type method.

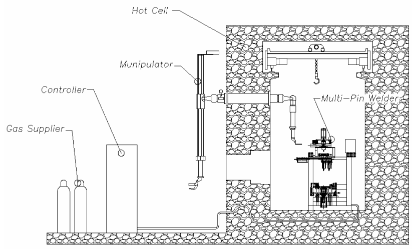


Fig 2. Schematic drawing of the remote welding system.

2.2 Design of Modular Welding Equipment

A remote RW equipment[2]consists of a main head, a branch electrode indexer, an end plate loader, and an assembly tuner as shown in Fig. 3. The main head itself consists of a tungsten electrode, a step-down transformer, an air cylinder or other means of applying a change to the main electrode by using a cam lever. The electrode indexer provides an accurate rotation of the upper and lower index units during end plate welding operations. The rotary indexer driven by the servo motor is adjustable to allow for the length of the overall shafting to vary as the indexing units are raised and lowered. The shafting is fitted together by means of linear guide and linear bearing slides. The jigging plate using branch electrodes provides an accurate seat for the bundle end plates and the 37 elements. This part aligns the weld electrode with the elements ends during a weld operation. The jigging plate is made of a Be copper. The end plate loading mechanisms are used at the upper and the lower units. The loaders dispense and load either the upper or the lower end plates to the bundle during a welding operation. A reloadable magazine provides a supply of end plates to the units, which are dispensed one at a time by an air cylinder. An assembly tuner is incorporated into the end plate transfer gripper tooling to execute a rotation of the end plate which is required during a transfer. This unit is very robust and thereby adheres to the permissible load restrictions so they will require no maintenance. The 3D modeling design of the remote RW equipment was also investigated by the SOLIDWORKS program as shown in Fig. 4. Additionally preliminary remote operation performances to improve the RW equipment will be reviewed by using a 3D animation method.

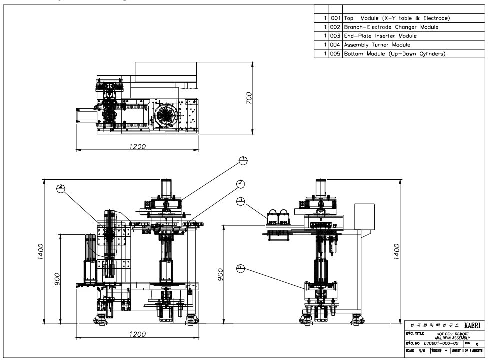
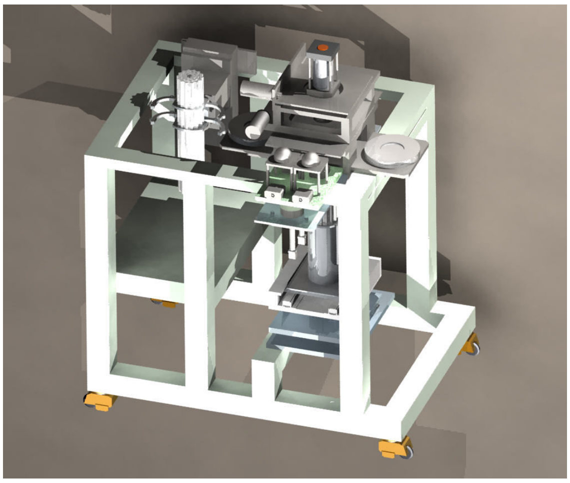
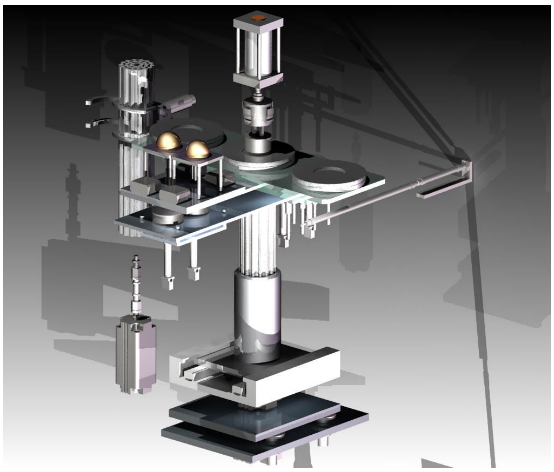


Fig 3. Basic drawing of a remote welding equipment.



(total views)



(modular views)

Fig 4. Basic drawings of a remote welder by using 3D.

3. Conclusion

This study was implemented to develop the remote welding equipment for a DUPIC bundle fabrication and to review the basic drawings by means of a 3D design consideration. To establish the reliability of the RW process and the remote welding system, it is necessary to carry out a simulation of a remote operation by using a 3D animation method. So, the optimum welding equipment will be applied to the remote end plate welding process for a DUPIC bundle fabrication.

Acknowledgements

This work was performed under the Long-term Nuclear R&D Program sponsored by the Ministry of Science and Technology.

REFERENCES

[1] J. D. Sullivan, AECL's Progress in Developing the DUPIC Fuel Fabrication Process, The 10th KAIF/KNS Annual Conference, 1995.

[2] Bundle Assembly Welding Equipment, GE Canada Nuclear Products, Contract Item No. A7. 2, 1995.