Improvement of Uncertainty for a remote-controlled Impact Tester in Hot cell

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1. Introduction

The remote-controlled impact tester[1], which has been operated in the hot cell of IMEF (Irradiated Materials Examination Facility)[2,3,4,5,6,7] since 1994, has been used to obtain the absorbed energy of a irradiated specimen to evaluate the surveillance program of the pressurized vessel for light water reactor (LWR) as well as to support the R&D of advanced steels for future reactors. In general, a obtained absorbed energy is much affected by a specimen transferring system and a specimen temperature control system of physical and environmental elements. Therefore, these parameters are always kept to acquire a little low uncertainty. Recently the specimen transferring system of this machine was modified by adding two pneumatic actuators to confirm not only a close to full contact between a specimen and a pair of anvils, but also to position a specimen to the center of two anvils. As a result, the uncertainties of this test machine for NIST-CRM's high absorbed energy was improved from ± 1.7 % to ± 0.7 %.

In this paper, the improvement of uncertainty for a remote-controlled impact tester in the hot cell is studied and revaluated after adding an auxiliary device of a specimen transferring system.

2. Experimental & Results

2.1 Remote-controlled impact test system

The remote-controlled impact tester installed in the hot cell of IMEF consists of a specimen temperature control system, a specimen transferring system, and an impact tester as shown in Fig. 1. It is a method to get an absorbed energy of an impact specimen, which is heated up to +300 degree C or cooled down -150 degree C at the inside of a heating/cooling furnace, by moving an impact specimen from a furnace to anvils of an impact tester by means of a specimen transferring system without changing or losing the temperature of a specimen, and a located specimen will be stricken by a strike-tup within five seconds.

2.2 Used specimen transferring system

The specimen transferring system consists of a hand-operated-feed assembly with a square bar without an auxiliary device. The function of this is that a moved specimen from a heat/cool furnace should be located to the center of the anvils of impact tester under condition of almost full contact between a specimen and anvils. But because of temperature change in the hot cell, the alignment between an exit of heat/cool furnace and anvils of impact tester may be oriented a little, so a moved specimen could not fully contact to the anvils. Because of this reason described above, the uncertainty of an absorbed energy of a specimen would be increased.

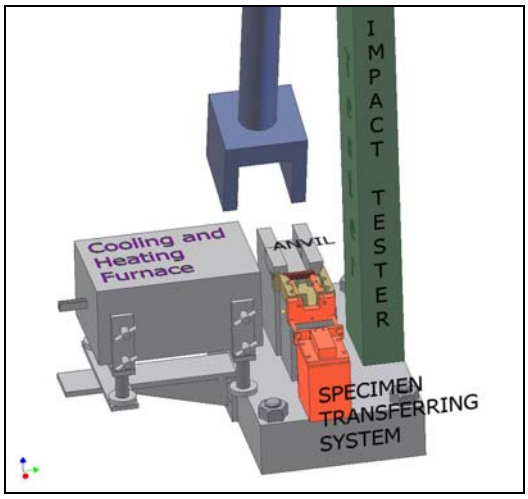

Fig. 1. 3-D view of a remote-controlled impact test system in IMEF.

2.2 Advanced specimen transferring system

To correct an alignment between a specimen and a pair of anvils as described in section 2.2, a new device was developed and installed as shown in Fig. 2.

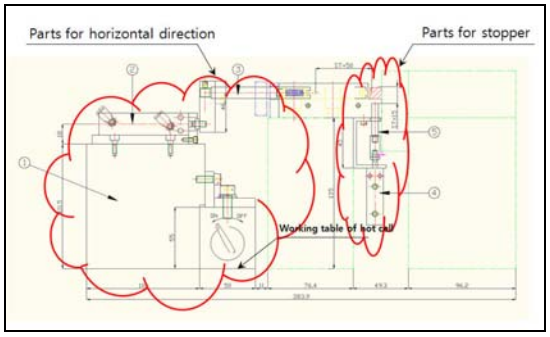

Fig. 2. Elevation View of an Advanced specimen transferring device with both parts for horizontal direction and for stopper.

It is handled and operated by the pneumatic system to secure full contact between a specimen and a pair of anvils. It consists of three air cylinders. Two of them are model CU16-50D operated with a 0.2 MPa and designed to push a specimen with push rods horizontally. The other is model CU10-15D operated with a same pressure value and designed as a stopper to locate a specimen to the center of two anvils by moving vertically. Also the Teflon is added to the end of push rod to avoid rapid temperature variation of a heated or cooled specimen.

2.3 Performance test of an advanced device

The CRM (Certified Reference Material) of NIST (National Institute of Standards and Technology) is used to confirm the performance of an advanced device with the designated specimens of high energy. The test results are listed in Tab. 1.

Table 1 Test results of NIST-CRM

No.	Specimen ID	Temperature (℃)	Measured Absorbed Energy (J)	Remarks
1	HH105-31	-40.0	99.180	1) Before modification 2) Uncertainty : 3.11 J (1.7%) 3) k =2, confidence interval : 95%
2	-351		92.900	
3	-621		90.110	
4	-992		91.550	
5	-1183		92.630	
6	HH120-0600	-40.0	106.79	1) After modification 2) Uncertainty : 1.53 J (0.7%) 3) k =2, confidence interval : 95%
7	-0636		105.70	
8	-0637		106.59	
9	-0638		109.27	

3. Conclusions

The improvement of uncertainty for a remote-controlled impact tester in the hot cell is studied and revaluated after adding an auxiliary device of a specimen transferring system.

An auxiliary device consists of two air cylinders of model CU16-50D operated with a 0.2 MPa to push a specimen with push rods horizontally and one air cylinder of model CU10-15D operated with a same pressure value to locate a specimen to the center of two anvils as a stopper by moving vertically. Also the Teflon is added to the end of push rod to avoid rapid temperature variation of a heated or cooled specimen.

The uncertainty of this test machine for NIST-CRM's high energy were improved from ±1.7 % to ±0.7 %.

But it is strongly recommended that the uncertainty of this test machine for NIST-CRM's low absorbed energy must be tested at -40.0 degree C.

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