Transactions of the Korean Nuclear Society Spring Meeting
Jeju, Korea, May 12-13, 2016

Preliminary ripple effect analysis for HTR 350MWt 4Modules construction

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1. Introduction

The VHTR has been considered as a major heat source and the most safe generation IV type reactor for mass hydrogen production to prepare for the hydrogen economy era.

As a part of a VHTR economic analysis, we have studied the VHTR construction cost and operation and maintenance cost. However, it is somewhat difficult to expect the exact cost due to insufficient reference data and experience.

As a result, we propose quantitative analysis techniques for ripple effects such as the production inducement effect, added value inducement effect, and employment inducement effect for HTR 350MWt × 4 module construction and operation ripple effect based on NOAK. This paper presents a new method for the ripple effect and preliminary ripple effect consequence.

2. Methods and Results

Inter-industry relation table and time series analysis techniques are used for a forecasting of the ripple effect by a HTR construction and operation.

In this section, some of the techniques used for the time series model. Input-output data are described. We derived the time-serial functions for the projected years 2016-2035 using the historical input-output data from the years 2005-2012.

2.1 Assumption

To calculate the ripple effect, we assumed the following:

- HTR (350MWth × 4 Module) for the nth of kind.
- HTR construction cost and Operation & Maintenance Cost is following the KAERI report [1]
- Reactor construction starts in 2016 and the HTR construction period is 5 years for the KAERI report [1]
- The inter-industry table uses the input-output data for the "electric and steam" account for the historical years 2005-2012, and for the projected years 2016-2035.
- We only consider 15 years to calculate the ripple effect after the HTR reactor construction based on the KISTEP (The Korea Institute Science and Technology Evaluation and Planning) report's recommendation [3]
- The operation and maintenance cost is considered with a 3% interest rate.

2.2 Inter-Industry relation table

- An inter-industry relation table is an integration statistic recording table for the national economy. It shows the flow of the commodities from the production through intermediate use by industries to purchases by final users. These data were developed as a set of matrices or tables for each years. It is presented on the former basis, reflecting in part the collection mechanisms for many other data sources such as research and development R&D expenditures data, employment statistics, pollution data, and energy consumption, which are mainly collected by the enterprise or by the establishment, and thus according to the industry classifications.
- It consists of 30 accounts. We have mainly used the 16th account "Electric and steam" provided by the bank of Korea [4-10]. Figures 1, 2, and 3 show the latest data for the years 2005-2012.

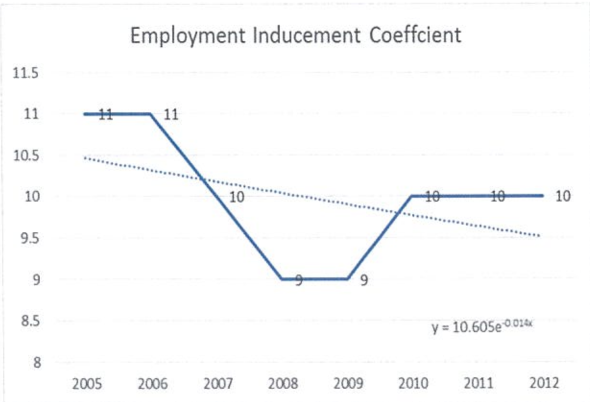

Fig. 1. Employment Inducement Coefficient

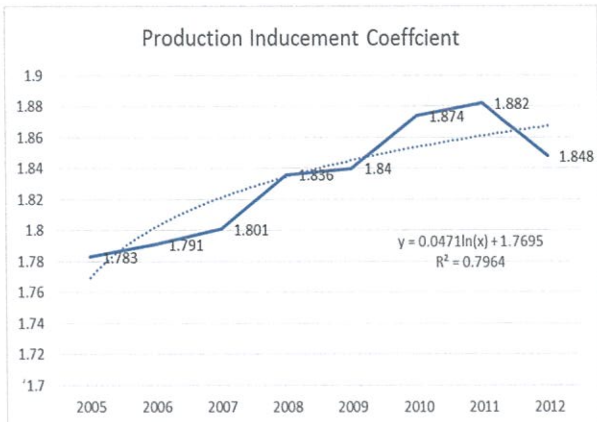

Fig. 2. Production Inducement Coefficient

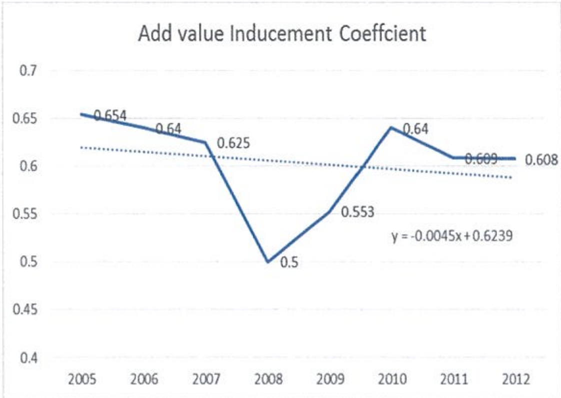

Fig. 3. Add value Inducement Coefficient

2.3 Time Series Analysis

A times series is a collection of observations of well-defined data items obtained through repeated measurements over time. Based on the annual Korea bank inter-industry relation table for the historical years of 2005 to 2012 regarding the employment inducement, production inducement, and added value inducement, we derived the inducement coefficient time series function.

We selected the most explanative time series functions after performing the statistical analysis such as ANOVA (Analysis of variance), for a goodness of fit test. Table I shows the ANOVA result for the production inducement coefficient.

Table I: ANOVA result for production inducement

회귀분석 통계량	
다중 상관계수	0.890168
결정계수	0.792399
조정된 결정계수	0.757799
표준 오차	0.018266
관측수	8

분산 분석

	자유도	제곱합	제곱 평균	F 비	유의한 F
회귀	1	0.007641	0.007641	22.90162	0.003045
잔차	6	0.002002	0.000334		
계	7	0.009643			

	계수	표준 오차	t 통계량	P-값	하위 95%	상위 95%	하위 95.0%	상위 95.0%
Y 절편	-25.259	5.660955	-4.46196	0.004274	-39.1108	-11.4071	-39.1108	-11.4071
구분(전력,가스,수도 및 건설	0.013488	0.002818	4.785563	0.003045	0.006591	0.020385	0.006591	0.020385

Major serial functions for each projected inducement coefficient can be formulated as follows:

- $y = 0.0471\ln(x) + 1.7695$ for production inducement time series
- $y=10.605*\exp(-0.014x)$ for employment inducement time series.
- $y= -0.0045*x + 0.6239$ for added value inducement time series function

where y and x are the projected inducement coefficient value and year, respectively.

Table II shows the expected inducement coefficients for employment, production, and added value from 2016 through 2035.

Table II: Expected inducement coefficients

Year		Expected value		
		Employment Ind. Coef.	Production Ind. Coef.	Add Value Ind.Coef
During Construction	2016	8.9282	1.8865	0.5699
	2017	8.7853	1.8903	0.5654
	2018	8.6424	1.8938	0.5609
	2019	8.4995	1.8970	0.5564
	2020	8.3566	1.9001	0.5519
	2021	8.2137	1.9029	0.5474
	2022	8.0708	1.9056	0.5429
After Construction	2023	7.9279	1.9082	0.5384
	2024	7.7850	1.9106	0.5339
	2025	7.6421	1.9129	0.5294
	2026	7.4992	1.9151	0.5249
	2027	7.3563	1.9172	0.5204
	2028	7.2134	1.9192	0.5159
	2029	7.0705	1.9211	0.5114
	2030	6.9276	1.9230	0.5069
	2031	6.7847	1.9247	0.5024
	2032	6.6418	1.9264	0.4979
	2033	6.4989	1.9281	0.4934
	2034	6.3560	1.9297	0.4889
	2035	6.2131	1.9312	0.4844

2.3 Annual Expected Inducement Coefficients

The time serial functions is applied to derive the expected inducement effect. The annual construction cost and O&M cost are based on the KAERI report. The specific construction and O&M costs will be presented at the conference due to confidentiality. From the annual cost application, we derived the annual ripple effect. Table III shows the annual expected inducement effect.

Table III: Expected Inducement Effect

Year		Expected Inducement Effect		
		Employment I.E(Men)	Production I.E. (Billion-KRW)	Add value I.E (Billion-KRW)
During Construction	2016	445	94	28
	2017	1,168	251	75
	2018	8,222	1,801	533
	2019	9,955	2,221	651
	2020	9,998	2,273	660
	Partial -Sum	29,789	6,642	1,949
After Construction	2021	2,515	582	167
	2022	2,471	583	166
	2023	2,427	584	164
	2024	2,384	584	163
	2025	2,340	585	162

Year		Expected Inducement Effect		
		Employment I.E(Men)	Production I.E. (Billion-KRW)	Add value I.E (Billion-KRW)
	2026	2,296	586	160
	2027	2,252	586	159
	2028	2,209	587	157
	2029	2,165	588	156
	2030	2,121	588	155
	2031	2,077	589	153
	2032	2,034	589	152
	2033	1,990	590	151
	2034	1,946	590	149
	2035	1,902	591	148
	Partial -Sum	33,129	8,810	2,369
Total		62,917	15,452	4,318

3. Conclusions

We proposed a ripple effect analysis method using a time series and inter-industry table. As a result, we can predict that a 350MWth × 4 module HTR reactor construction will bring about a 62,917 employment effect, 15,452 billion KRW production effect, and 4,318 billion added value effect for 22 years. It is known that APR1400 reactors (1 module) export ripple effect is about 8,500 billion KRW. As a result, HTR construction has more effective effect than that of APR1400. However, it is necessary to use the sub-account values of an inter-industry table to obtain a more precise effect result.

ACKNOWLEDGEMENTS

This study has been performed under mid-and-long term Nuclear R&D Project by the Ministry of Science, ICT and Future Planning, Republic of Korea.

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