VHTR Construction Ripple Effect using Inter-Industry Analysis

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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 VHTR 600MWt × 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 VHTR 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 2016-2037 using the historical input-output data from the years 2005-2012.

2.1 Assumption

To calculate the ripple effect, we assumed the following:

- VHTR (600MWth × 4 Module) for the nth of kind.
- VHTR construction cost and Operation & Maintenance Cost is following the KAERI report [1]
- Reactor construction starts in 2016 and the VHTR construction period is 7 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 2016-2037.
- We only consider 15 years to calculate the ripple effect after the VHTR 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.

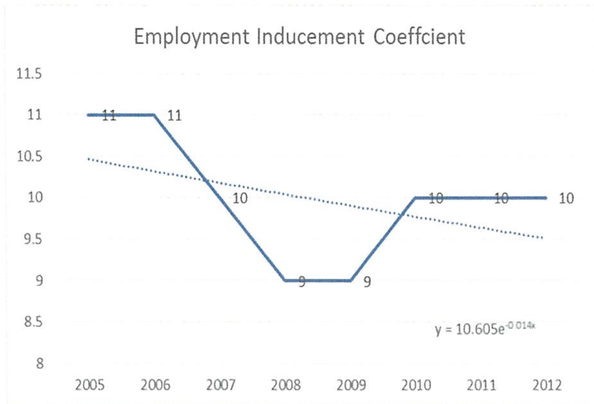

Fig. 1. Employment Inducement Coefficient

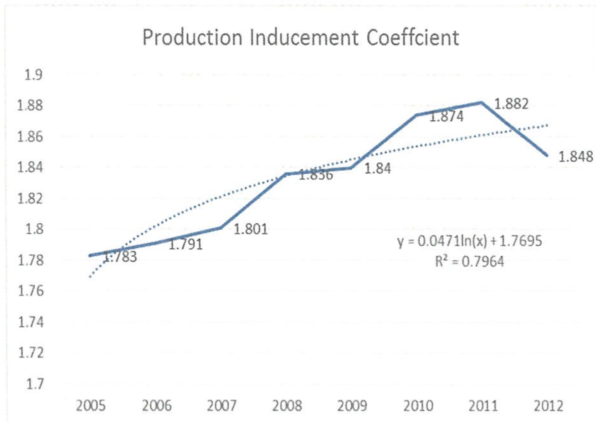

Fig. 2. Production Inducement Coefficient

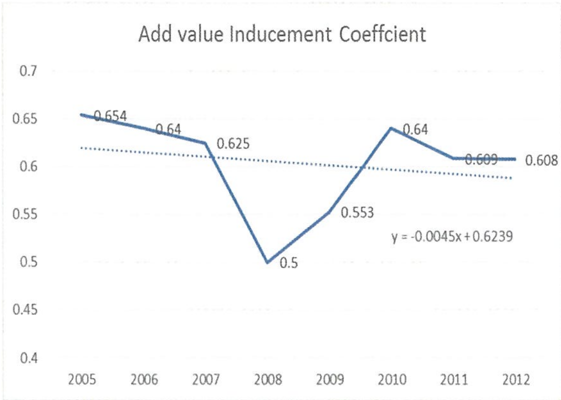

Fig. 3. Add value Inducement Coefficient

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 2037.

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
	2036	6.0702	1.9327	0.4799
	2037	5.9273	1.9342	0.4754

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	545	115	34
	2017	1,431	307	92
	2018	1,408	308	91
	2019	692	154	45
	2020	8399	1,909	554
	2021	11,145	2,582	742
	2022	11,838	2,795	796
	Partial -Sum	35,458	8,173	2,357
	2023	447	852	240

Year		Expected Inducement Effect		
		Employment I.E(Men)	Production I.E. (Billion-KRW)	Add value I.E (Billion-KRW)
After Construction	2024	460	879	117
	2025	474	907	119
	2026	488	935	122
	2027	503	964	124
	2028	518	994	127
	2029	534	1,025	129
	2030	550	1,057	132
	2031	566	1,089	134
	2032	583	1,123	137
	2033	601	1,158	140
	2034	619	1,193	143
	2035	637	1,230	145
	2036	656	1,268	148
	2037	676	1,307	151
	Partial -Sum	8313	15,987	2,114
Total		43,771	24,160	4,472

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 600MWth × 4 module VHTR reactor construction will bring about a 43,771 employment effect, 24,160 billion KRW production effect, and 4,472 billion added value effect for 22 years.

It is necessary to use the sub-account values of an inter-industry table to obtain a more precise effect result. However, the methodology can be applied with minor modifications to another reactor type.

ACKNOWLEDGEMENTS

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