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Three Years Operation of Ocean Nutrient Enhancer TAKUMI in Sagami Bay

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ABSTRACT

TAKUMI the prototype of Ocean Nutrient Enhancer, which upwells and discharges Deep Ocean Water (DOW) in the euphotic layer and increases a primary production in the sea, was set up in Sagami bay in May 2003. Since then, TAKUMI has been continuously upwelling the DOW of 100,000m3/day from the 200m depth, even in the case of rough sea condition. In this paper, the design concept and three years operation experience of TAKUMI is reported briefly. It seems that TAKUMI is the world first successful device for artificial upwelling and increasing primary production in the real sea.

KEY WORDS: Deep Ocean Water; Primary Production; Upwelling; Floating Structure; Riser Pipe; Density Current

INTRODUCTION

To increase a primary production in the sea, Upwelling and discharging a Deep Ocean Water (DOW) which has very rich nutrient salts into the euphotic surface layer has been proposed by many oceanologists as a "Fishing ground of artificial DOW upwelling" (Liu, 1999). Table 1 shows the comparison of the area and the productions in the sea in case of the ocean, the coastal and the upwelling area (Ryther, 1969). The world half fish production is made in the upwelling area which is only 0.1% of the whole sea area, for example, offshore Peru, Canary Islands, etc. But, so far, there are no successful means to make it artificially, because of the problems of the large amount of upwelling DOW, the dilution of nutrient salts in the sea, enduring the rough sea condition, the strength of very long riser pipe for upwelling, etc.

Table 1. Production in the Sea

	Sea Area		Primary Production		Fish Production	
Area	10^6 km3	Ratio(%)	10^9 tonC/year	Ratio(%)	10^6 ton/year	Ratio(%)
Ocean	336	90.0	16.3	81.5	0.16	0.07
Coastal	36	9.9	3.6	18.0	120.00	49.97
Upwelling	0.36	0.1	0.19	0.5	120.00	49.97
Total	372	100.0	20.0	100.0	240.16	100.00

MARINO-FORUM 21, a subsidiary of The Fisheries Agency of Japanese Government, established the budget of about USD 6 million and organized the research and development project to create Ocean Nutrient Enhancer (ONE for short) which upwelles and discharges DOW into the euphotic layer to increase primary production of the sea and make a fishing ground. The project started in April 2000, and the term has five years. The device was named TAKUMI. The members and their roles for the project are shown in Table 2.

Table 2. Members of TAKUMI Project

Member Company	Role
Ouchi Ocean Consultant	Project Manager
IHI Marine United	Floating Construction
JFE Engineering	Riser Pipe
Nakashima Propeller	Pump & Diesel Generator
Japan Radio Corporation	Electronic Apparatus
System Intech	Data Processing
Zenilite Buoy	Light & Signal
Mitsubishi Heavy Industries	Mooring Design
Toa Corporation	Set-up Work
Mitsui OSK Techno-Trade	Operation & Maintenance

The featuring technologies of TAKUMI as a prototype of Ocean Nutrient Enhancer are as follows.

1) Density Current Generator;
   The way of rising DOW and putting it into the euphotic layer.
2) Rotational Flow in Sagami Bay;
   Choice of the setting point of TAKUMI to avoid the thinning of nutrient salts.
3) Submersed Spar Type Floating Structure and Steel Riser Pipe;
   Configuration of the floating structure and riser pipe to withstand against rough sea condition of the open ocean.
4) Upending;
   Proper way of setting up in the actual sea.

In this paper, the above technology concept is evaluated through three years running operation of TAKUMI in Sagami Bay.