

## THE STUDY OF INFLUENCE OF UNDERWATER EXPLOSION ON MARINE ORGANISM AND MARINE ENVIRONMENT

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**ABSTRACT** This paper mainly discuss the influence of underwater to explore oil on the aquatic resources, according to the test of on - the - spot imitation in the Laizhou Bay in June 1983. The impact of pressure wave which demolish and produce on fish, shrimp, crab and shellfish were tested and collected and analyzed the water samples of around explosion. The result showed that the main influence factor on sea water quality are suspended matter and inorganic nitrogen etc. The explosion wave which blow up underwater has a proper lethal action on marine organisms, but the lethal sphere is not big and there is bigger harm on their larva, egg and plankton.

**KEYWORDS** Underwater explosion, Pressure wave, Marine organisms, Marine environment

### PREFACE

Explosive as seismic focus to explore oil has been used over a long period of time, especially in the coastal zone and inshore fishing ground. It has been accepted long ago that the explosion wave which explosive instantaneously explodes and produces in seawater has a damaged effect and even lethal effect on the marine organisms. Therefore, non - explosive, has lighter injury to marine organisms trend in the process of oil exploration in seawater. But because of non - explosive (as air - gun) used in the shallow waters along the coast is extremely inconvenient, the explosive as seismic focus is still used during exploratory oil. It has been still adopted to detect oil using explosive underwater such that the Liaohe and Dagang oil field at present. Meanwhile, these area is also the spawning area and feeding ground of fish and shrimp, therefore, it is very important that we grasp and understand the level of harm and impact of offshore seismic exploration on marine organisms no matter what strat off from aquaticangle and oil development angle.

So far, only a few test about this field in the demesostic and abroad were carried out and

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their experimental scales were small and were only confined to small amounts of explosive, Norway "Statz" Institute had carried out the influence test of explosion upon fish, shellfish and plankton, they used 50g explosive to carry on continuation of explosion for ten times in Norwegian off coast in June 1966. The result was found that none of fish and shellfish died from blast by means of observation of diver, 50% of plankton were affected, especially *copepod*, the harm was much greater<sup>[3]</sup>. But there were large differences between practical petroleum prospecting operation and the experiments. So this paper is mainly based on the data obtained from the simulating experiment of petroleum prospecting demolition in the Laizhou Bay and associating with the other similar experimental results. The effects of shock waves produced by demolition in the water on the marine organisms and marine environment are discussed in this paper. It will provide the reference to relieve the harm of marine petroleum prospecting operation on the marine organisms and marine environment and attain the purpose which consideration is given to both of the petroleum development and the protection of marine resources.

## MATERIAL AND METHOD

### (一) Material

TNT explosive as the seismic focus was adopted to explode in the fixed layer of water. The amount of explosive used is 1kg, 3kg and 5kg respectively. The organisms which were tested is mainly *Mugil soiuy*, *Nibea albiflora*, *Lateolabrax japonicus*, Nauplius, Postlarval, Shrimp larva, *Arca subcrenata*, *Macra veneriformis*, *Portunus trituberculatus* and *Chaetoceros* spp. The body length of organisms which was tested were: fish 15–25cm; shrimp, postlarval 1–1.7cm, shrimp larva 3–3.4 cm, nauplius 3–4 stage, *Acetes chinensis* 2.8–3.2 cm, crab 10–13 cm, shellfish 2.5–4.0 cm.

### (二) Method

The shotpoint, observation point and contrast point were fixed with floating ropes in the sea. Observation points were set up at 4m, 8m, 16m, 32m and 64m respectively as away from shortpoint. The distance between the shortpoint and contrast point was 1200m. A set of string boxes or string bags which contained organisms tested were hung in every observation point. At the same time, the hydrophones were hung on the every observation point so that determined the sound pressure level and sound spectrum by means of recorders. The explosive was ignited in under water of 1.5 m (fig.1). The water samples and organisms tested were immediately taken on the ship after explosion and checked on the conditions of death of organisms. The glutamic-oxalacetic transaminase, glutamic-pyruvic transaminase and choline esterase of fish in blood serum were determined, meanwhile, each factor of chemistry round about explosion and condition of meteorology, temperature and salinity were analyzed.

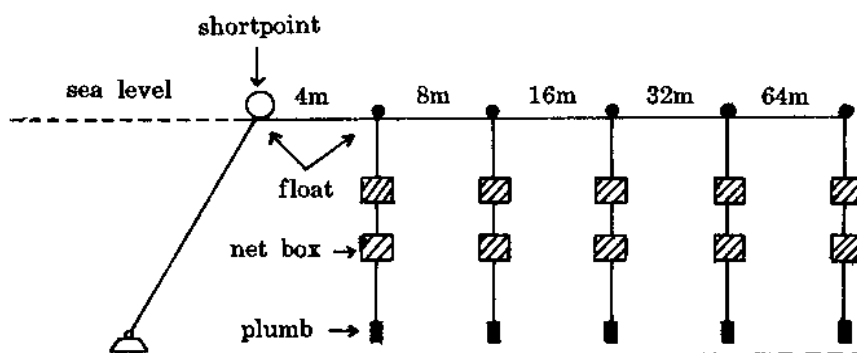


Fig. 1 The sketch figure of imitation test on the influence of marine organism

## RESULT AND DISCUSSION

### (一) Influence of underwater demolition on marine organisms

#### 1. Lethal experiment on marine organisms

It is one of more serious methods that explosive is blown up in sea water to explored oil. It is the main method from the 1960's right up to the beginning of 1980's for the seismic exploration oil. The oil exploration used as explosive in shallow sea is still used up till now. The direct sufferers are organisms such as fish, shrimp, crab which live on the circle of explosion action, Tabel 1. Lists the level of influence on marine organisms by using the different amount of explosive. The results show when the explosion of 1kg is exploded under water of 1.5m, fish will have death of 50% and to *Acetes chinensis* will have 88 - 94.2% within 8m apart from explosion centre. There are still the death of 50% to *Acetes chinensis* apart from 16m and 32m of explosion center. It is thus clear that the level of damage to them is: *Portunus trituberculatus* and shellfish have higher anti - seismic quality. The explosive of 3kg and 5kg have a more serious effect on organisms underwater explosion and the results of both of them are more similar. Every organisms has much more difference to bear the ability of sound wave, *Acetes chinensis* and crab are more able to bear the vibration and so that its death rate is lower. Fish and shrimp are more frail to explosion wave and the death rate is more higher, especially upon to the larva of fish, shrimp and shellfish, because these larva are weak in swimming capacity and have poor escaping capacity when has a outside striking produced by underwater blast and can cause the death of eggs and larvae within the cycle of action directly. According to the results of experiment, the damage rate of larva is larger than the same kind of adult organisms with the same pattern of explosion and the amount of explosive, for example, the body length are 9 - 10cm of shrimp, 1.0 - 1.5cm of postlarval, and a few millimeter of nauplius, they suffer from damage to be greatly different, the damage rate of postlarval and nauplius are ten times as large as adult shrimp (Table 2).

#### 2. Experiment of influence on plankton

Plankton tested were caught by trawling around the test ground. The mixed samples of plankton were used because it was unable to separate on the ship. The live and death plankton were separated after explosion, tested samples were fixed with formaldehyde. Then, it was brought to land so that was classified and identified. Among all of the tested samples, the amount all of *Mysidacea* held the superiority in some samples, and the amount of *Chaetoceros* spp held the superiority in other samples. The results show that the underwater explosion to explore oil is quite serious to the influence of plankton (Table 3).

**Table 1 The influence of different amount of explosive on the main death rate of organisms**

Kinds	Amount of explosive	4m	8m	16m	32m	64m	Contrast
<i>Mugil soizu</i>	1kg	50	50	0	0	0	0
<i>Nibea albiflora</i>	3kg	100	100	100	100	0	0
	5kg	100	100	100	100	0	0
<i>Acetes chinensis</i>	1kg	94.2	88	60	56.7	4.2	0
	3kg	bottle	broken	/	/	0	0
	5kg	36	26.5	17	0	0	0
<i>Portunus trituberculatus</i>	1kg	31	20	/	0	0	0
	3kg	60	33	25	0	0	0
	5kg	20	0	0	0	0	0
<i>Arca subcrenata</i>	1kg	10	25	0	0	0	0
	3kg	35	30	0	5	0	0
	5kg	38	30	16.6	8.3	8.3	0
<i>Mactra veneriformis</i>	1kg	23	18	0	0	0	0
	3kg	80	30	10	25	0	0
	5kg	68	70	60	28	5	0

**Table 2 The influence of underwater explosion on the mean death of different growth stage of shrimp**

	0m	8m	16m	32m	64m	Contrast
Adult (9-10cm)	7.4	0	0	6.6	0	0
Postlarval (1-1.5cm)	64	75	52	20	24	25
Nauplius (3-4 stage)	62	8	11	11	9	0

### 3. The influence of the explosion wave on physiological effect of fish

Transaminase is called transamino - enzyme for short , it catalysis the amino - group of alpha - amino - acid to alpha - ketoni - group. This process plays a important role to the metabolism of amino - acid in the body of animal. Under the normal conditions, the vitality of transamino - enzyme is much smaller in the blood serum than in tissue. When tissue take place pathological changes or damage, it will cause transamino - enzyme is greatly released in tissue and make the transamino - enzyme exceed its normal level. So we determined the activity of

transmino - enzyme (Table 4).

**Table 3 The influence of underwater explosion on the mean death of plankton**

Sort	Amount	4m	8m	16m	32m	64m	Contrast
<i>Mysidacea</i>	1kg	75	50	36	14.3	3.6	0
	3kg	net	38.1	22	/	18	0
	5kg	broken	broken	50	25	18.2	0
<i>P. marine Stuto</i>	1kg	66	33	12.5	16.5	/	0
	3kg	net	83	25	29	/	0
	5kg	broken	broken	53	25	43	0

**Table 4 The glutamic - oxalacetic transaminase of *Mugil soiyi* and sound intensity**

	Amount of explosive	4m	8m	16m	32m	64m	Contrast
Activity ( $I\mu$ )	1kg	83	80	56	50	60	45
	3kg	/	>190	160	94	30	6.7
	5kg	190	>190	108	114	73	43
25 - 160Hz sound intensity (dB)	1kg	/	124	123	119	115	/
	3kg	/	140	137	124	124	/
	5kg	/	142	135	124	120	/

The results showed that *Mugil soiyi* had appeared the physiological phenomenon which transmino - enzyme was released to blood serum from tissue cell when explosion wave is produced. The glutamic - pyruvic transaminase and choline esterase were not as regular as glutamic - oxalacetic transaminase, they reflected only its activity to trend to the normal value along with the far and near of distance which was away from shortpoint. By means of analysis of a great majority of samples in contrast point, the normal values to the glutamic - oxalacetic transaminase, glutamic - pyruvic transaminase, choline esterase of *Mugil soiyi* can obtained preliminarily to be 50  $I\mu$ , 19  $I\mu$ , 23  $I\mu$  respectively.

## (二) The influence of underwater explosion on marine environment

### 1. The changes of heavy metal

The heavy metal has some influence on marine organisms. The level of influence depends on the properties, concentration and pattern of heavy metal and the kind of organisms. Therefore, it is one of concerned contents that the content of heavy metal bring about change by underwater explosion. It can be seen from table 5, the content of heavy metals were all lower than the first - class of the seawater quality standard no matter before or after explosion. The explosion underwater did not cause the change of the content of heavy metals in sea water, the reason was that it might be relation to the lower content of heavy metals in sediment. After explosion, the heavy metals in sediment did not exert the clear phenomenon which were dissolved in seawater.

## 2. Change of organic matter

COD and TOC are the reflection on the content of organic matter more or less in seawater. The analytical results showed that the content of COD and TOC had somewhat increase after explosion (Table 5). This may be relation to the some of organic matter dissolved in seawater when sediment and seawater are fully mixed. The variance of TOC is clearer and its value increased by 0.85 mg/L, but due to no evaluation standard, it can not be given a claeer evaluation. The mean value of COD increased by only 0.05 mg/L, so its influence on the seawater was less.

**Table 5 Analytical results of seawater samples around explosion (mg/L)**

Items	Before explosion	After explosion	Items	Before explosion	After explosion
Turbidity (degree)	257	453	pH	8.09	8.07
Suspended matter	429	694	Cu	0.0012	0.0009
Inorganic nitrogen	0.392	0.427	Zn	0.0089	0.0083
Petroleum	0.010	0.010	Pb	0.0067	0.0056
DO	7.23	7.29	Cd	0.0002	0.0003
COD	2.17	2.22	Hg	0.00001	0.00002
TOC	3.35	4.20			

## 3. Variance of inorganic nitrogen

When ammonia dynamite is exploded in the condition of lacking oxygen, a great amount gas such as nitrogen oxide, nitrogen dioxide and ammonia are produced. Some of them can be dissolved in water, the results showed that the content of inorganic nitrogen in seawater increased less than 10% round about explosion (Table 5). It had not obvious influence on marine environment. But if large-scale underwater explosion is engaged in estuary or eutrophication waters, the content of inorganic nitrogen will may be increased greatly. If the increment of inorganic nitrogen is too big, it may exceed the limited value of nutrition and cause the possibility of harmful consequences and affect the ecosystem directly.

## 4. Variance of suspended matter and turbidity

The results showed that the increment of turbidity and suspended matter were 196 degree and 265 mg/L respectively after explosion. The seawater quality standard in our country which demands on the suspended matter is that: the first-class, second-class and third-class standard are less than 10 mg/L, 50 mg/L and 150 mg/L respectively<sup>[1]</sup>. The increment of suspended matter which was caused by explosion was 26.5 times as many as the first-class standard water quality standard and 1.77 times as many as the third-class sea water quality standard. So it can be given from above-analysis, the main influence of underwater explosion on the seawater are the increase of turbidity and suspended matter. If under water explosion is carried out for a long period of time in some waters, it may bring about the higher turbid water mass. It will affect the surroundings ecosystem and threaten marine organism resources, owing

to the action of transposition, diffusion and subsidence which are produced by tidal current.

### 5. Variance of pH and DO

The mean value of pH after explosion was decreased by 0.02 compared with that of before explosion. The reason may be that the gas of nitrogen oxide and nitrogen dioxide which are produced after explosion and changes the pH value when these gases meet with the water. The water column of 10m high was bit by explosion, seawater and air were contacted fully so that made the content of dissolved oxygen in seawater to be increased. In fact, this phenomenon benefits the marine organisms and also decomposition of organic matter and sulphide.

## CONCLUSION

To sum up, underwater explosion can create a certain effect on marine environment and marine organisms. The results are obtained preliminarily as follows.

1. The influence factors of underwater explosion on the marine environment are mainly the increase of turbidity, suspended matter and inorganic nitrogen, and the main influence factors are turbidity and suspended matter. If marine organisms live in turbid water for a long time, its gill will be full of suspended matter and affect its breath and growth. And even bring about suffocation. In addition, if the content of suspended matter is excessive for a long time, it will obstruct the normal growth of egg and larva of marine organisms and destroy their living condition and restrain the photosynthesis of aquatic organism and cut down the bait of marine animals.
2. The explosion wave which produced by explosion has some influence on marine organisms. When the amount of explosive is 1kg, the influence on it is less than that of 3kg and 5kg, but their range of influence is not big. It can be thought that it will be safety area further than 64m. Moreover, the explosion wave by blowing up, besides making the fish death near the explosion centre, can also make fish escape quickly further than safety area. In so far as continuous explosion, if it is gone on within the distance of 50 – 100m, except first explosion, the every other explosion inflict casualties on the journey fish directly to be relatively smaller. Therefore, if underwater explosion to detect oil is carried on in some waters for a long time, it will play a role which drive out fish greatly, especially in forbidden fishing zone, it may also make the living conditions of marine organisms to be destroyed and result in some fishes which are used to laying egg, rearing larva and looking for bait to swim to other waters and cause the deficiency of fishing resources.
3. The main endanger of underwater explosion upon the marine organisms is in the forbidden fishing period. Within 4 – 5 months every year, a great number of fish and shrimp swim to offshore area to lay egg and journey. The number of parents is the base which maintain the reproduction of resources, the number of larva will affect the commercial yield directly. The explosion wave produced by explosion can cause death to the various egg and larva of fish, shrimp and crab, it will make the fishing resources suffer heavy losses and affect the reproduction of fishing resources. At the same time, for the shellfish and benthon which are the semi-lethal condition after explosion, they are also hard to escape the destiny of suffocation and death when



they are buried under a great amount has also a certain influence on economic shellfish.

4. If underwater explosion to detect oil is adopted, especially in forbidden fishing zone and busy season of catch and egg-laying area of fish, shrimp, crab and shellfish will be kept away. So it is necessary to formulate the forbidden period or change over to non-explosive as seismic focus such as electromagnetic pulse and air-gun etc<sup>[3]</sup>. Thus, it can make the losses of fishing resources to reduce the lowest level and reach the consideration of both the fishery production and oil development.

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## 水中爆破对海洋生物及海洋环境的影响研究

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**摘 要** 本文主要根据 1983 年 6 月在莱州湾现场模拟水中爆破勘探石油对水产资源的影响实验, 分别实验了爆破所产生的声压波对鱼、虾、蟹、贝类和浮游生物的影响, 采集并分析了爆炸前后的海水样品。由实验结果得出, 水中爆破对海水水质的影响主要因素是: 悬浮物、无机氮等。水中爆破所产生的声压波对海洋生物有一定的致死作用, 但致死范围不大, 而对水产资源的幼体和浮游生物伤害较大。

**关键词** 水中爆破, 声压波, 海洋生物, 海洋环境