Design of the DISSUB Hyperbaric Rescue Course Control Base on Hybrid Control Theory

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ABSTRACT:
Submarine crew rescue would be difficult when the broken DISSUB (distressed submarine) cabin is in hyperbaric status. The common submarine rescue systems are the Deep Submergence Rescue Vehicle (DSRV) and the Rescue Bell. But most rescue system cabin internal pressure-bearing is less than 0.6MPa atmosphere absolute (0.6ATA), the hyperbaric rescue depth is limited to 50 meters. For broken DISSUB rescue, it is a key point to carry out rapid decompression and holding crew habitat in a safe range. At present, the naval ventilation system is only making ventilation and air exchange, allowing considerable margin of error by reason of manual operation mode. This paper use a hybrid control system to achieve precise control for the whole ventilation and rapid decompression based on a developing Distressed Submarine Ventilation Decompression System (DSVDS). The decompression course control is more complex, it includes a discrete event dynamic system (DEDS) and a continuous variable dynamic system (CVDS), and related factors of mutual interaction and influence. The layering model which is based on hybrid control theory divides the whole course into three parts: discrete events, interface and continuous dynamic system. It can achieve integrative control and optimization for discrete and continuous status. This paper analyzes this new technique in the DISSUB rescue field, and the research effort should be applied to the developing a new submarine and rescue vessel. KEY WORDS: DISSUB; hyperbaric rescue; decompression; DSVDS; hybrid control; Petri net.

INTRODUCTION
It was noted (He, 2009) that the developing of submarine rescue always has three hard cores: submarine crew survival, escape and rescue. It depends on two ways: the first is to build a rescue system (DSRV, ROV, and so on) which is supported by the RSV (rescue surface vessel) and air force (transporter, and helicopter) in order to bring forth the systems to the DISSUB. The second is to research dive physiology, design a new submarine crew survival system and escape apparatus to promote the living capability. Nowadays, key points of submarine rescue mostly focus on these fields:
- Decompression sickness prevention and cure;
- DISSUB crew survival;
- Standardization for rescue equipments;
- The treat and cure of a large number of wounded;
- Hyperbaric rescue.

Up to now, DISSUB crew survival and hyperbaric rescue have not been effectively resolved. When the disabled submarine crashes to the bottom, the false hull would be broken and flooded in most cases. To assure crew survival in the damaged cabin, it needs to blow down water using hyperbaric gas in order to prevent flooding even more. Even if crew entered into the intact cabin or finished damage control, it is also kept in a hyperbaric environment in the DISSUB. After long stop under hyperbaric condition, crews would meet a hard nut to crack in the course of returning to the surface. The first is the survival problem in the hyperbaric cabin. The second is safety decompression technology which can let crews leave the DISSUB to return to the surface normally.
There are two common hyperbaric rescue methods which are used in the world.
- Using rescue systems which, like the DSRV, actualize under-pressure rescue.

Gong (2003) proposed the system must keep the same internal pressure with DISSUB and rescue crews. Only if it returns to the mother-ship, the crew enters into the deck decompression chamber and accomplishes decompression. This method is safer to crews, and can supply adequate medical care. But it is so strictly that rescue systems have to suffer heavy pressure, need more gas source and energy power. Since most rescue system cabin internal pressure-bearing is less than 0.6MPa atmosphere absolute (0.6ATA); the hyperbaric rescue depth is limited in 50 meters. Building a hyperbaric-bearing rescue system, is not achievable overnight. It requires a lot of money, a long building period, complicated supporting equipment, and a large rescue vessel.
- Carrying out rapid decompression.

After decompression is finished, crews can return to the surface which use single escape equipment themselves or aboard the rescue system. It was also noted BROWN, 1999) that rescue systems in most countries don’t own the deeper depth hyperbaric rescue ability at the present stage. So, it is important to develop hyperbaric rapid decompression technology, make crew survival and decompression sickness treatment research, and build new type DSVDS (disable submarine ventilation decompression system).
In recent years, there has been exploration of new ideas and technologies in the hyperbaric rescue field. Through all kinds of experiments, experts are trying to establish safe DISSUB rapid decompression tables.