Singlet Oxygen Generators – The Heart of Chemical Oxygen Iodine Lasers: Past, Present and Future

Kevin B. Hewett[1]

Air Force Research Laboratory, Directed Energy Directorate, 3550 Aberdeen Ave. SE, Kirtland AFB, NM 87117-5776, USA

Since the initial demonstration of chemical oxygen iodine lasers in 1977, researchers have realized that the heart of the COIL system is the singlet oxygen generator. This drives the performance of the system in terms of output power, mass efficiency, engineering complexity, reliability and maintainability. For this reason the singlet oxygen generator has been the focus of intense research and development efforts over the last 30 years. This paper reports on the history of singlet oxygen generators – starting with the simple sparger design used in the initial COIL demonstration and ending with current jet or droplet generators used in laboratories around the world. The relative performance of the different generator types will naturally lead to performance goals for the research efforts of the future.

Four classes of generators which react chlorine with a basic hydrogen peroxide (BHP) have been identified [1]; the (1) sparger, (2) wetted-wall, (3) jet, and (4) aerosol generators. Each of these classes is described briefly along with two key performance parameters, the utilization of chlorine and the yield of singlet oxygen.

The sparger bubbles chlorine gas through liquid basic hydrogen peroxide. This type of generator formed the basis for the initial COIL demonstrations. Spargers typically have utilizations that approach unity, however, the yields were only 35-40% [2-3]. The wetted-wall generator passes chlorine over a surface which is coated with a thin film of BHP. The prototypical wetted-wall generator is the rotating disk generator where the liquid film is replenished by rotating the surface through a liquid bath of BHP. This is the type of generator used on RADICL at the Air Force Research Laboratory in the 1990's which reported utilization of 95% and yields of singlet oxygen between 52 and 56% [4]. Jet generators form the third class of generators. Here, jets of liquid BHP are injected into gaseous chlorine. Jet generators have been built where the gas and liquid flows are in a co-flow, counter-flow or cross-flow configuration. The yield and utilization of jet generators are both high; the yield is on the order of 60% and the utilization is >90%, such as that reported by the Boeing research group in 1997 [5]. The final class of generators is the aerosol or spray generator. Here, the BHP is atomized into a fine aerosol and mixed into the chlorine. These generators have been reported to have yields of ~60% with utilizations near unity [6].

Based upon both historical and current performance results, recommendations for future singlet oxygen generator research will be made.

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[1] E-mail: afrl.rdlc.sci.org@kirtland.af.mil