The Separating effect of the sea, Biodegradation in the sludge layer, More nutrients in the sea

1. The Separating effect of the sea.

When we see in the television the accumulation of plastic debris in the so-called "hot-spots", as a phenomenon of convergence caused by the persistent flow direction of superficial waters in the ocean, we must realize that over 95% of those plastics (macro and micro) are only of a very few types, namely Polyethylene (PE), Polypropylene (PP), and expanded Polystyrene (XPS), since most of the other plastic types have specific gravities over 1 g/cm3, and consequently they sink to the bottom of the ocean.

Different Types of PE will be certainly present such as Low density PE (LDPE), Linear low density PE (LLDPE), High density PE (HDPE), and in the closed cell foams XPS will be largely dominant, minor amounts of polyurethane foam (PU) are also found [Ref.1].

Most of the other plastic types, such as Polyesters, Polyurethanes, Polyvinylchloride, Polyethylene Terephthalate, will sink to the sea bottom. Small rubber and plastic particles will take days to weeks to sink, but larger pieces will sink in a few hours.

Once arrived at the bottom of the sea, the plastic particles are included in the bottom sludge layer, where the anaerobic processes are largely dominant [Ref.2].

2. Biodegradation in the sludge layer

For many decades, the plastic producers took care to optimize their resistance to oxidation and to the ultraviolet radiation, to increase durability, but in the sludge, there are no light and dissolved oxygen is very close to zero [Ref.3].

Resistance to anaerobic degradation processes are rather poor for most of the common plastic types [Ref.4].

Recognized exceptions are PTFE and PVDF whose specific gravity is so high that the internal free volume is minor and consequently they present a very high chemical resistance, as well as biological resistance are a result of "molecular impermeability".

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On the contrary, Rubber, namely SBR, as most of the other elastomeric materials, have a very large internal free volume, and this is a very relevant characteristic to favor the biological attack that occurs in the deep-sea sludge environment.

It is well known that the biological processes under anaerobic conditions tend to remove Oxygen and Sulfur atoms, as well as most of the other heteroatoms.

In the anaerobic treatment of waste waters, the removal of heavy metals as well as sulfur is based on the insolubilization, with subsequent removal in the filter cake, and the efficiency of the process is very often correlated with the insoluble fraction of the Total Organic Carbon (TOC), and that is a strong indication of bioaccumulation in the cells of themicroorganisms consortia.

The composition of the bottom sea sludge is not so easy to study, since the predominant color is dark black, and therefore the conventional microscopy proves to have a very limited use, and special analytical methods have to be used such a Nuclear Microscopy and micro FTIR mapping [Ref.5].

The kinetics of plastic and rubber biodegradation inside the bottom sea sludge have been scarcely studied, but it is recognized that the complete degradation takes months to a few years for thermosets, and for most rubbers and thermoplastics extensive to complete biodegradation within the first year is to be expected.

Recognizing that most precise and accurate data is required, a Scientific Team (of IPMA, CIIMAR and IST University) is planning to completely simulate in laboratory the deep sea conditions (pressure, absence of oxygen and light) and with a real sample of recently recovered bottom sea sludge to follow the biodegradation processes of rubber (“rubber infill” granulates) and a few plastics. This work is planned to start soon, being the results at the end published in a paper.

3. More nutrients in the sea.

The more important nutrients for algae are the nitrate ion, the phosphate, and the ammonium, but for the nutrition of the krill, organic molecules and small organic particles, besides the algae, are also important as carbon source.

Differences in temperature are the main cause for the phenomena called “upwelling” in which we have a flow coming from the bottom of the sea, and transporting with it nanoparticles [Ref.6], and a rather smaller amount of small micro particles, resulting from the catabolic processes of the microorganism’s consortia, and bringing up nutrients for the krill.

Biodegradation products of the thermoplastics and rubbers can then have a positive impact on the food chain in the ocean.

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