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# CHEMICAL SWARM ROBOTICS

*Innovation in field of Chemical Engineering*

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***Abstract:*** ***Due to the abrupt rise in population, the demand for energy has increased tremendously. The current challenge is to meet all these demands in future. To tackle the problems of energy crisis, the only solution is to become self-reliant in all means.***
***This research work focuses on the innovation in the field of chemical engineering i.e. Chemical Swarm Robotics and its application for the formation of Fischer Tropsch Diesel.***

***Keyword- Swarm***

## I. INTRODUCTION

The aim of the project is to develop chemical processing systems based on the principle of swarm robotics. The inspiration for swarm robotics comes from the behavior of collective organisms such as bees or ants that can perform complex tasks by the combined actions of many relatively simple, identical agents.

The main scientific challenge of this project is the design and synthesis of chemical swarm robots, which we envisage as internally structured particulate entities in the 10-100 micrometer size range that can move in their environment, selectively exchange molecules with their surrounding in response to a local change in temperature or concentration, chemically process those molecules and either accumulate or release the product. Such chemically process autonomous entities can be viewed as very simple pre- biotic life forms ("artificial cells"), although without the ability to self- replicate or evolve.

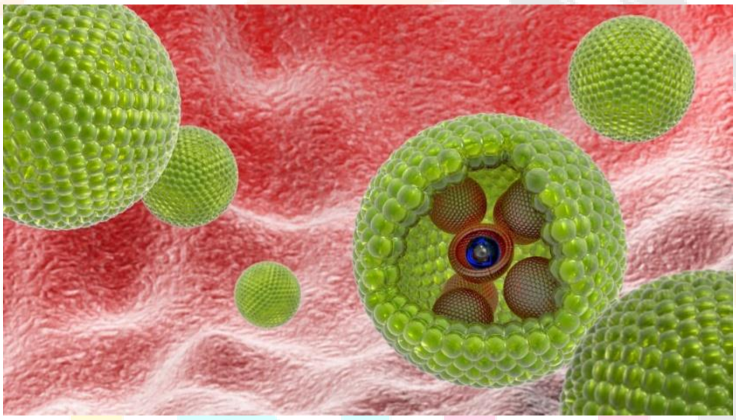


**Figure 1:** 3D model of chemical robots inside live tissue. Semi permeable shell is made in green inner compartments in brown and active core of inner compartments in blue

## II. BASIC TERMS

Cells- The smallest unit of an organism that is classified as living organism. Ability to take in nutrients, converts these nutrients into energy, carry out specialized functions, reproduce, and respond to external and internal stimuli. [1]

Chemo-taxis- Cell movement through the medium by following chemical gradients. Positive (the movement in the direction of a higher concentration of the chemical compounds) or Negative (the movement in the opposite direction). [1]

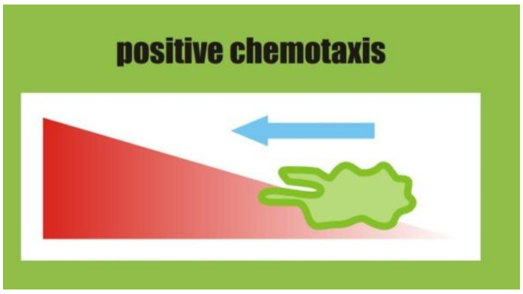



**Figure 2: Positive Chemo-taxis**

Swarm Behavior- Collective behavior of independent individuals in large populations. Coherent collective motion of fishes, birds, insects or microorganism. [1]

**Figure 3: Swarm behavior of fishes**

## III. STRUCTURE OF CHEMICAL SWARM ROBOTICS

Chemical Swarm Robotics work on the principle of swam robotics. Artificial system behaves in a similar way as natural swarms. The size range 10 micrometer- 100 micrometers. Freely moves in their environment either passively or actively. It exchanges molecules with their surroundings. These are chemically process certain molecules and either accumulate or release the product according to the needs. These molecules are selectively bound to specific surfaces.

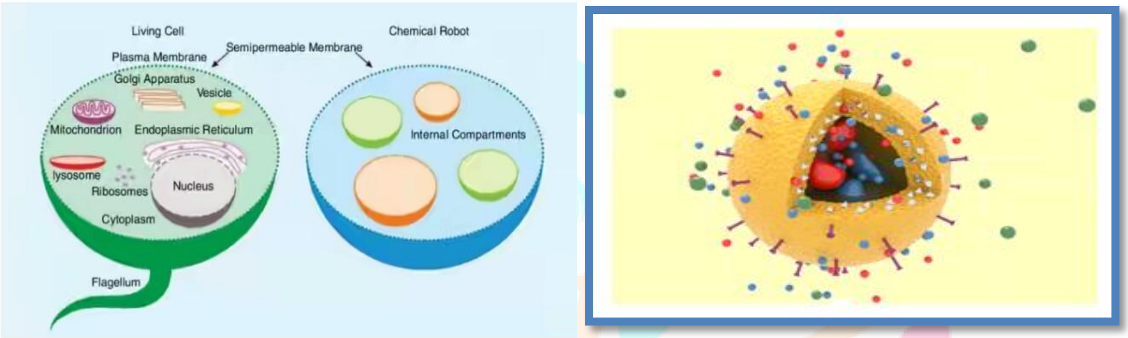
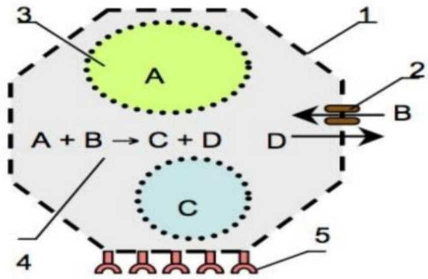



**Figure 4: Basic structure of chemical swarm robotics**

Basic Principle and working process of chemical swarm robotics




**I.** Outer shell
**II.** Selective transport ("on-off" permeable membrane)
**III.** Internal compartments for storing reactants
**IV.** Internal chemistry "on demand"
**V.** Adaptive surface for anchoring to target

## IV. WORKING MECHANISM FOR THE FORMATION OF FISCHER TROPSCH DIESEL

**Reduction of Carbon di oxide to Carbon Monoxide**

The electrochemical reduction of carbon dioxide to carbon monoxide is usually described as :-

$$CO_2 + 2H^+ + 2e^- \longrightarrow CO + H_2O$$

The redox potential for this reaction is similar to that for hydrogen evolution in aqueous electrolytes. This reduction can be performed by using metal carbon dioxide complexes.

**Chemical Swarm Robotics for Electrochemical Reduction**

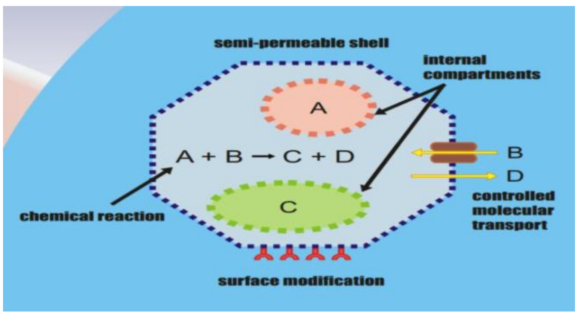



**Figure 6: Robot 1 reaction**

A: Carbon dioxide ($CO_2$)
B: Acid ($H_2SO_4$)
C: Water ($H_2O$)
D: Carbon monoxide (CO)

**Fischer Tropsch Process**

In this mixture of carbon monoxide and hydrogen gas is converted into liquid hydrocarbons.

Reaction Mechanism

$$(2n+1)H_2 + nCO \longrightarrow C_nH_{(2n+2)} + nH_2O$$

In this formation of methane is unwanted because n varies from 10-20 to form straight chain of alkane that is Diesel.Converting a mixture of $H_2$ and CO into aliphatic product include multistep reaction. The growth of the hydrocarbon chain may be visualized as involving a repeated sequence in which hydrogen atoms are added to carbon and oxygen, the C-O bond is splits and a new C-C bond is formed. For one -$CH_2$- group produced by [2]

$$CO + 2H_2 \longrightarrow -(CH_2)- + H_2O$$

**Catalyst**

A variety of catalysts can be used for the Fischer- Tropsch process, but the most common are the transition metals Cobalt, Iron, and Ruthenium. Nickel or iron can also be used, but tends to favor methane formation ("methanation") [2]

**Chemical Swarm Robotics for Fischer Tropsch Process**

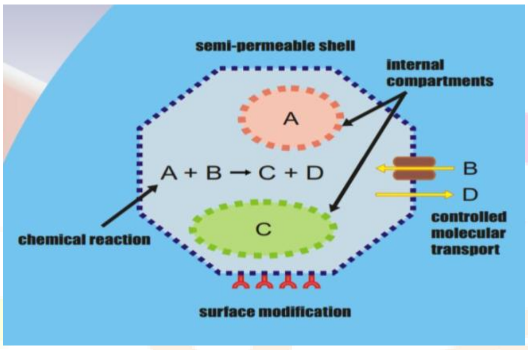



**Figure 7: Robot 2 reaction**

A: Hydrogen ($H_2$)
B: Carbon monoxide (CO)
C: Water ($H_2O$)
D: Diesel ($C_nH_{(2n+2)}$)
E: Cobalt, Iron

## V. RESULT AND DISCUSSION

The final product from these is paraffin, olefins, FT Diesel, and methane.

In general, the product distribution of hydrocarbons formed during the Fischer–Tropsch process follows an Anderson–Schulz–Flory distribution, which can be expressed as:

$$\mathbf{W_n/n = (1-\alpha)^2\alpha^{n-1}}$$

Where $W_n$ is the weight fraction of hydrocarbons containing $n$ carbon atoms. $\alpha$ is the chain growth probability or the probability that a molecule will continue reacting to form a longer chain. In general, α is largely determined by the catalyst and the specific process conditions.

If α is less than 0.5 it tends to form methane, if α is greater than 0.5 it leads to form long chain hydrocarbon. [3]

## VI. CONCLUSION

The carbon dioxide present in the nature can be reuse by the help of chemical swarm robots. Hydrogen and carbon dioxide reacts over cobalt-based catalyst to form methane, which is every useful product because it has highest heat of combustion, otherwise we can get fischer tropsch diesel.

The other applications of chemical swarm robotics

1. In environmental operations (e.g. clean-up of toxic spills)
2. In distributed chemical processing (thousands of miniature "chemical factories" acting on a distributed feedstock, rather than a concentrated feedstock being brought to one large factory for processing).
3. In pharmaceutical applications (targeted drug delivery, custom synthesis of personalised medicines)
4. In microplastic capturing technology

## VII. ACKNOWLEDGMENT

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