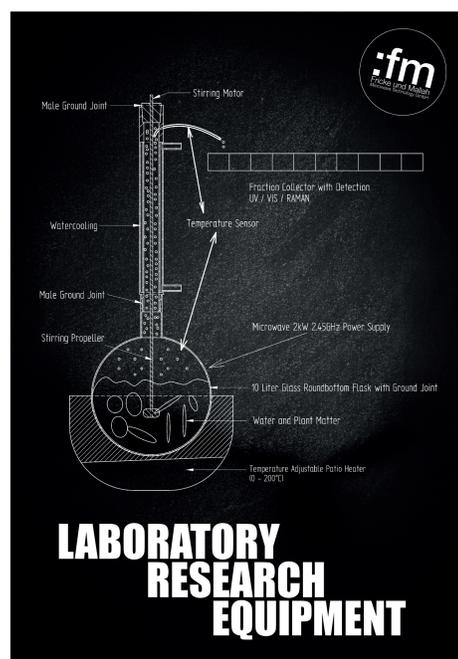


# Microwave technology and its environmentally friendly applications

Prof. Dr. Gerald Grübler, Ursula Steiner and Dr. Eberhard Heller Research and Development, Betttau 11, 88131 Bodolz

Hans C. Zimmermann, Abacus Analytical Systems GmbH, Bottroper Weg 2, 13507 Berlin

Marcel Mallah, Fricke und Mallah Microwave Technology GmbH, Werner-Nordmeyer-Straße 25, 31226 Peine



The application of the microwaves started 82 years ago in radar systems. Nowadays they are conventionally used for the heating of food.

If you are analyzing the amount of publications about microwave technology in 50 different magazines in the time window of 1962 to 2023, you can state an increase of citations about extraction procedures by 85 times and for synthesis procedures by 99 times.

In the meantime the microwave is used for chemical synthesis and analytic, the isolation of pharmaceutical agents, recycling procedures of polymers and for disinfection and decontamination (1, 2, 3, 4, 5).

The microwave technology is characterized by its highly efficient energy transfer, low use of electricity and solvents.

An action learning vocational education at schools and universities of applied sciences by the use of modern methods such as microwave technology is successful by the synthesis of pharmaceuticals such as acetylsalicylic acid and paracetamol with a yield of about 90% using the simultaneous synthesis time of 30-40 minutes(6).

Ursula Steiner presented at the world congress of education at Sapporo, Japan on January 11, 2022 a video about „team-teaching in sciences and english“.

This method was first developed in Canada and is called „content and language integrated learning“ (CLIL). It means that a teacher in sciences and English teach together a scientific subject in English and German.

For example a chemistry teacher carries out experiments by the microwave and the pupils should explain the experiments in English and German.

A specific vocabulary list is given to the pupils about microwave technology.

The second step is that they carry out own experiments, write the minutes and draw a conclusion about advantages and disadvantages of microwave technology.

Finally the lesson is assessed by a target.

Pupils can attach dots in fields 1 and 3 and give further comments (7, 8, 9).

The advantage of this method is that pupils learn the specific english language use in chemistry and can apply it practically.

Teachers can exchange their methods and knowledge. A scientific study has shown that pupils learn more during a teamteaching lesson compared to teaching two subjects separately.

Moreover girls who are more interested in languages could be also attracted to a bigger interest in sciences by team-teaching in sciences and English.

Due to my experience teachers and pupils alike have shown a bigger motivation compared to normal lessons.

New technologies, energy consumption and the economic handling with resources gain more and more significance.

With low electricity and solvent consumption procedures such as material separation processes, synthesis of multilevel chemicals, isolation of aromatic fragrances, production of biofuels, drying processes of food as well polymer reactions and chemical recycling processes of polymers, can be carried out efficiently.

The microwave technology replaces the continuous, the time and energy consuming extraction procedures, just like maceration, decoction, infusions, steam distillation, ultrasonic, soxhlet and liquid processes with supercritical CO<sub>2</sub> as well as research laboratories and the chemical pharmaceutical industry.

For optimal reaction conditions are extreme flexible and potential microwave systems, a continuous temperature control and an exact monitoring of the fractions by UV-, VIS- and RAMAN-spectroscopy are the preconditions, which allow a direct online monitoring of the total reaction process.

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