Non-Lethal Defense III - Conference

Non-Lethal Weapons Activities at ICT

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1. German Definition of Non-Lethal Weapons(Slide 1)

At first I want to inform of the German definition of NLW:

Non-Lethal Weapons are:

„Technical means whose intention is to obviate (prevent or stop) hostile operations without causing death or lasting injury to human beings.

In addition, secondary effects caused by the use of those means to innocent people, property, and environment shall be minimised“.

This refers to the basic study of DASA.

2. Activities on Non-Lethal Weapons in Germany(Slide 2)

Slide 2 gives an overview about the activities. These activities started in the end of 1993 when German MOD placed an order with DASA for working out a study on NLW. It was followed by the foundation of a BWB-study group in 1995 and a presentation on NLW in the test area of the German army in Hammelburg which was organised also by BWB in 1996.

In the middle of the last year BWB placed three orders, first the development of a Ranging Gun and additional an Effector Net, second an Infra Sound Generator and third an Audible Irritating Sound Machine.

3. Activities on Non-Lethal Weapons at ICT(Slides 3 & 4)

As mentioned previously main area of working fields of ICT concern technological tasks. Based on a technological approach main competencies of ICT must be taken as a basis for a co n-ception as to the topic of Non-Lethal Wea pons.

For this the scientific and technological basis concern:

- Particle Technology
- Polymer Technology
- Gas-Generator Technology
- Combustion Technology

Developing several Project-Ideas is resulting in concrete tasks, projects or co ncepts on Non-Lethal Technologies. In this case the tasks include a project on Infra Sound and conceptions on foams and entanglements.

4. Infra Sound Project (Slides 5 & 6)

The goal of this project is the development of an Infra Sound-generator.
It started in May 1997.

* In phase 1 first step was the modification of an existing acoustic modulated Jet-burner. For the generation of higher infra sound levels there is a substantial need of energy required. For this purpose particularly oscillating combustion processes are preferred because - determined by characteristic features of system - a certain part of energy is being converted in acoustical flu c-tuations of pressure. Our first goal concerned of the generation of a continuos combustion pro c-ess. Heart of the technical equipment has been an acoustical modulated Jet-burner of type Gluareff operating with a gas mixture of propane/air.

* Second step included following series of tests:

- determination of the frequency spectrum of the original combustion chamber
- investigation of the frequency spectrum as for variable lengths of the res onant pipe,
- investigation of the frequency spectrum caused by modulation of fuel supply

These tests have been carried out.

* Making use of the results of these experiments and as planned in phase 2 to develop and construct a new demonstration model, we have come to the decision that this one will be based on a system of generating acoustic pressure waves. Our goal concerns sufficient high energy in combination with frequencies lower than 20 Hz.

* A look at our time-schedule presented by slide 6 shows that we will finish this project in N o-vember 98.

5. Concepts (Slides 7 - 16)

5.1 Materials

At this time the following material will be applied

Polyurethane
Polyamide
Polyester
Thermoplastic Elastomers
Phenolic Resins and will be thought about
Biodegradable Substances

With regard to the application of biodegradable substances there could be solved problems like cleaning-up.

5.2 Principally Characteristics of the Technologies

Before the description starts there is to point out some main differences between the technol o-gies which are of interest.

* The polymer or the polymer mixture can be commercial available as a finished product like a granulate (one Container system), or it has to be developed from basic materials on the basis of a polymeric process which results in a reaction pol ymer.
I prefer the second way because the reaction process is exothermic, so the course of reaction does not depend on any additional energy supply, the resulting m aterial is a molten mass. However using a granulate there has to be an energy transfer to the material in order to become molten. As the thermal conductivity of polymers is rather low there is some time to spend on it. Only the employment of micro waves would make sense.

* Differences between processes which use a solvent and processes which are solvent-free, are to separate. It is my intention to make more use of solvent-free o perations.

* With regard to the energy supply for dispensing, pressure can be inside the material system as a system parameter for instance in case of a super critical fluid
or the generation of pressure takes place using pumps or gas-generators.
On this occasion there will be a short description of the following four basic processes:
- Solvent-Process
- Super Critical Fluid-Process (SCF)
- Reaction Injection Moulding (RIM)
- Gas Generator-Process

5.3 Basic-Technologies

- Solvent-Process

Two polymeric substances are dissolved for instance by hydrochlorofluorcarbon (one-container system) and are under a certain pressure for dispensing.

- Super Critical Fluid-Process (SCFP)

Two basic materials are dissolved for instance by a fluid like carbon dioxide under super critical conditions (one container system). Although there is a molecular contact between the both substances, no chemical reaction results of it. As soon as the pressure will be reduced leaving the super critical region it occurs a chemical reaction and the formation of a new polymer.
It should be mentioned that the basic products also could be separated from each other in di f-ferent containers including different solvents.

- Reaction Injection Moulding (RIM)

This equipment is more complex and includes the following comp onents:

- two vessels contain the basic materials
- two high-pressure pumps
- a mixing-chamber

- some control-valves and nozzles and finally
- a dispenser.

RIM is a batch operation. The both basic materials are liquid and are stored, separated from each other, in heated vessels. The liquids are pumped under high pressure into the mixing-chamber, the heart of RIM-process.
What takes place here is called „high jet velocity impingement mixing“ and is characterised by a very strong intensity. As a rule the reaction rates are so high that the reaction takes place even when the monomers are being mixed. The reaction product can be dispensed immediately.

- Gas Generator-Process

The operation is similar to the one described before. More or less only the both pumps will be exchanged for one or several gas-generators. This means there is a formation of a reaction polymer.

There is an alternative option using gas-generators. Instead of manufacturing a reaction pol y-mer, a finished polymer could be employed as a basic material. Polymer granulate will be solved by a solvent to create a solution of high visco sity.
Under circumstances the solution and the nozzles have to be heated up.

- Unexpanded thermoplastic spheres

Compared to all processes described b efore the following method is rather different. Unexpanded polymeric spheres (beads) which consist of tiny liquid gas droplets e n-capsulated in a thermoplastic polymeric shell will be used. Under exposition of hot gases caused by gas generators, the thermoplastic shells soften at the same time as the liquid gas vaporises. The increased pressure causes expansion of the spheres to more than 60 times of their initial volume.

A large number of these spheres is inside a bag like an air-bag which is being blown up by several gas-generators and is being filled up. Due to closed contact between all the spheres the result is a cellular foam.

I want to add my personal view about these technologies .
RIM- and Gas Generator-Process show a very important advantage, because these processes are solvent-free. Therefore both operations are point of main efforts of our concepts at ICT.
Nevertheless I will speak about examples including all described technologies.

5.4 Examples of Basic-Technologies in combination with special Materials

- Solvent-Process

At this time there are applicable blends of elastomers and thermoplastic resins dissolved by hydrochlorofluorcarbon (HCFC) and used for the generation of sticky foams. HCFC is an acceptable interim solution.
This is a one container system under pressure.
Also thermoplastic elastomeres being mixed with HCPC show an additional option, this could be a Co-Polymer like for instance TPE-O or TPE-E.
However to find the right solvent could be a problem.

- Super critical Fluid Process (SCFP)

Polyol and Diisocyanate are the liquid raw materials. Both will be dissolved by Carbon Dioxide (CO_2) characterised by super critical conditions. As soon as there is a reduction of the pressure leaving the super critical region, it starts a chemical reaction which results in the formation of polyurethane.
Probably this process can be applied to further basic materials.
Application is to the manufacture of foams and entanglements.

- Reaction Injection Moulding (RIM)

In this case Polyol and Diisocyanate are basic materials again. The reaction rates are so high that reaction takes place even when the monomers are being mixed (In situ Polymerisation) and result in polyurethane.
This process also can be applied to the manufacture of further polymers like Polyamide or Polyester.
Applicable to the manufacture of foams and entanglements.

- Gas Generator-Process

- Reaction Polymers like a Polyurethane and a Polyamide can be manufactured, applicable to make foams and entanglements.
- On the basis of a Phenol and an Aldehyde, both in aqueous solution, there is a preparation of a Reaction Phenolic Resin as a result of a polycondensation.
An important goal is to create a biodegradable foam.
-Small not expanded beads made of polystyrene have been known for some time. At this time there are available further thermoplastic polymers which can be applied to build up foams within big bags.
- Cyanogen Acrylate could be an interesting one-component for spraying of e ntanglements.

6. Potential Operational Areas (Slides 17 & 18)

There are many optional applications of Non-Lethal Weapons, particularly as to Peace Oper a-tions under command of the United Nations.
Several studies on NLW have been carried out, very important are the extensive investigations of FINABEL, AGARD and DRG. Each study includes information on scenarios, range of appl i-cations, where Non-Lethal Weapons could be applicable. The following both slides give info r-mations of FINABEL and AGARD, that is to say the Non-Lethal Technologies with regard to appropriate operational areas. The study of DRG only makes difference between Anti-Personnel and-Material Weapons, nevertheless it supports the tendency of the other mentioned reports.

7. Optional Carrier Systems (Slide 19)

Slide 19 shows some examples of optional carrier systems which includes helicopters, mi s-siles, land crafts and persons. There will be a comment on suitability
being connected with technologies described before.
A Gas Generator is more qualified for small scale operations/area and as an instant energy source for the carrier units missile and person. On the other hand RIM-technology is more sui t-able for large scale operations/area and for land

crafts which can meet requirements as to size and volume of the technical equipment.

8. Combination of NLWs (Slide 20)

A combination of different Non-Lethal-Technology makes a lot of sense, to make sure that the effect for instance on crowds is as extensive as possible. It has been known for a long time that the effect on human beings depends on se veral parameters.
Basically there are material technologies like Sticky Foam and immaterial ones like High Power Micro Waves.

There are several strategies to employ NLTs. Technologies can work simultaneous, one after another or as peaks.
Slide 20 shows some examples of combined technologies.

9. Future study (Slide 21)

At last a comment on possible future trends with regard to described technologies. At this time at ICT there is a discussion on two ideas:

- Development of biodegradable foams and
- Development of an environmental friendly process on the basis of normal air as a blowing agent

Following slide shows the way as for the first task.

Definition

Non-lethal Weapons are: Technical means whose intention is to obviate (prevent or stop) hostile operations without causing death or lasting injury to human beings.

In addition, secondary effects caused by the use of those means to innocent people, property, and environment shall be minimised.

Review on Activities in Germany

11/93- 4/95 MOD -> Study to DASA

⇓

8/95 Establishment of a BWB Study Group

⇓

9/96 Presentation in Hammelburg
(Training Area of the German Army)

⇓

5/97-11/98 BWB -> 3 Projects:

|

Ranging Gun, Effector Net

|

Infra Sound

|

Audible Irritating Sound

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Technological Approach

⇓

Main Competencies at ICT

⇓

Scientific/Technological Basis of NLWs

- Particle Technology
- Polymer Technology
- Gas-Generator Technology
- Combustion Technology

⇓

Project-Ideas

⇓

Concepts of NL Technologies

- Infra sound without/with Irritant Materials
- Foams
- Entanglements

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Anti-Personnel Technologies

- Infra Sound without/with Irritants
- In-Situ Entanglements

Anti-Material Technologies

- Foams (sticky or rigid)

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Acoustic Infra Sound Project

Power -> Fuel

A Combustion driven Acoustic Generator, Type Gluareff

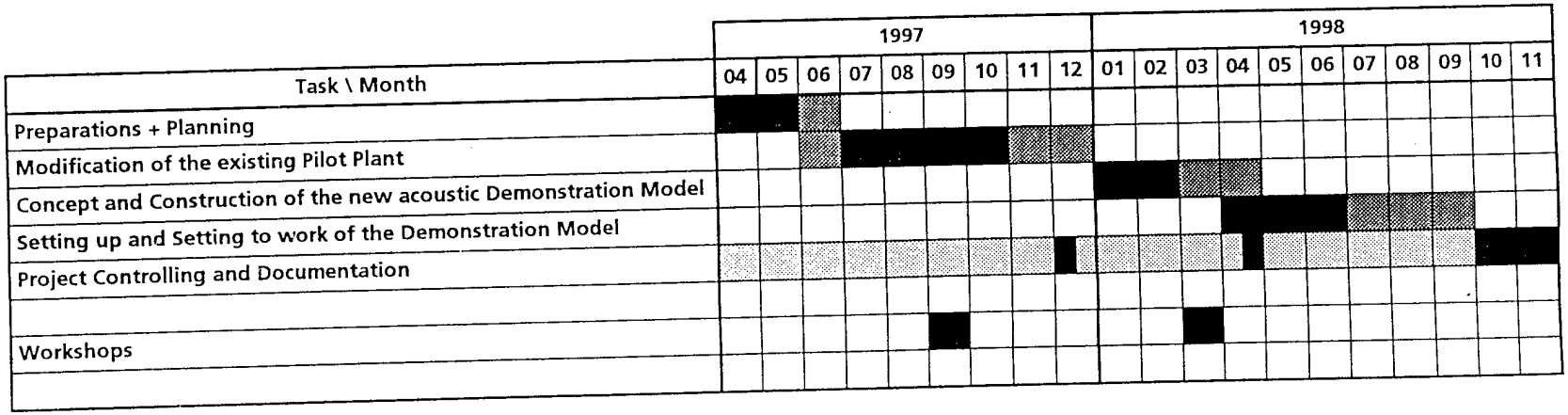
Phase 1:

1. Step: Modification of an Pilot Plant
2. Step: Realisation of a series of tests

Phase 2:

3. Step: Development and Construction of a new demonstration model

Working Schedule of the Infra Sound-Project



Legend:

- Planned Period of the described Tasks
- Possible additional Time for the respective Tasks
- Project Controlling

15.1.98/KDT

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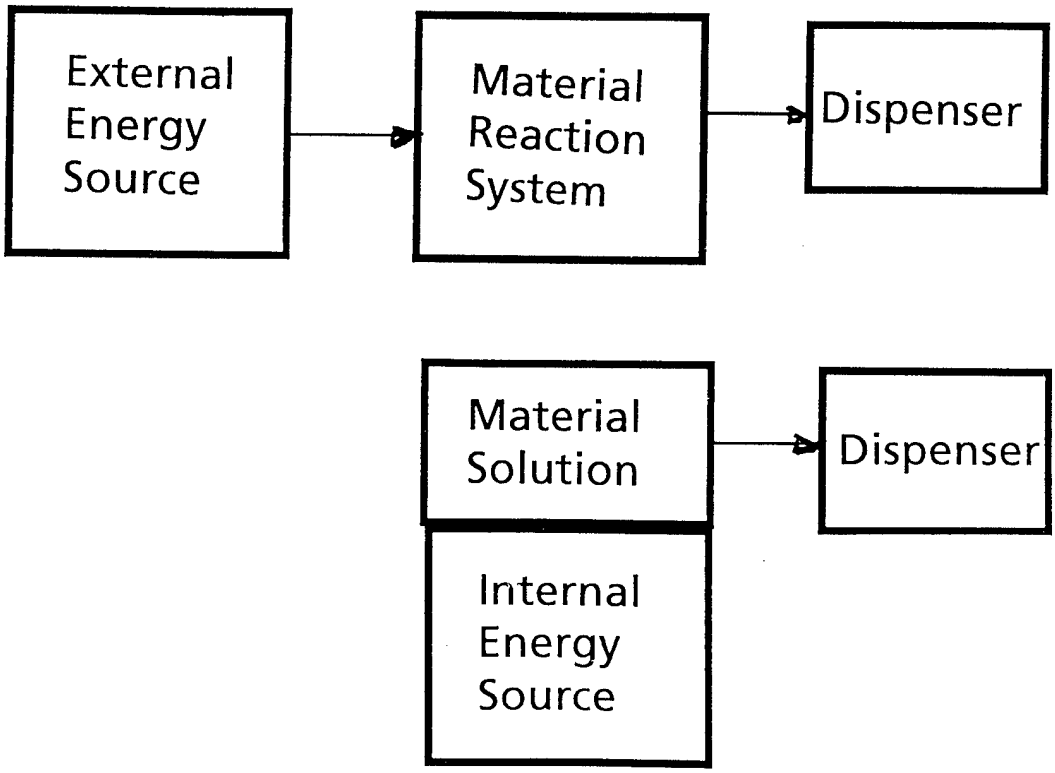
Materials

- Polyurethane
- Polyamide
- Polyester
- Thermoplastic Elastomers (Co-Polymers)
- Phenolic Resins
- Biodegradable Substances

Principally Characteristics of potential Technologies

- Finished Polymer <-> Reaction Polymer
- Solvent <-> Solvent-free
- Internal Pressure <-> External Pressure

Principally Structure of Technologies



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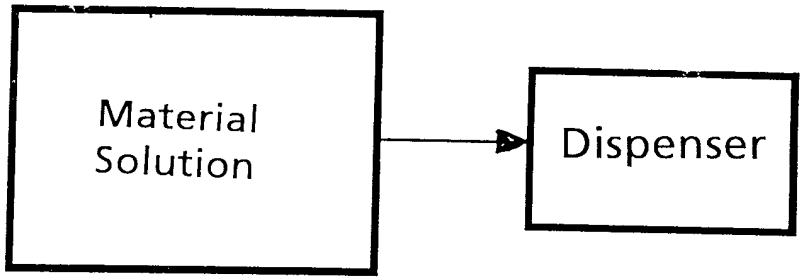
Solvent-Process



HCFC

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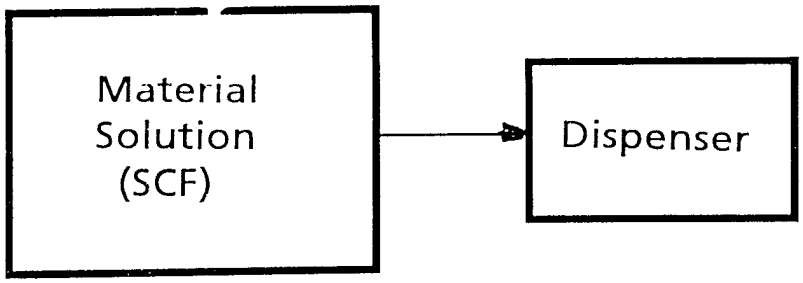
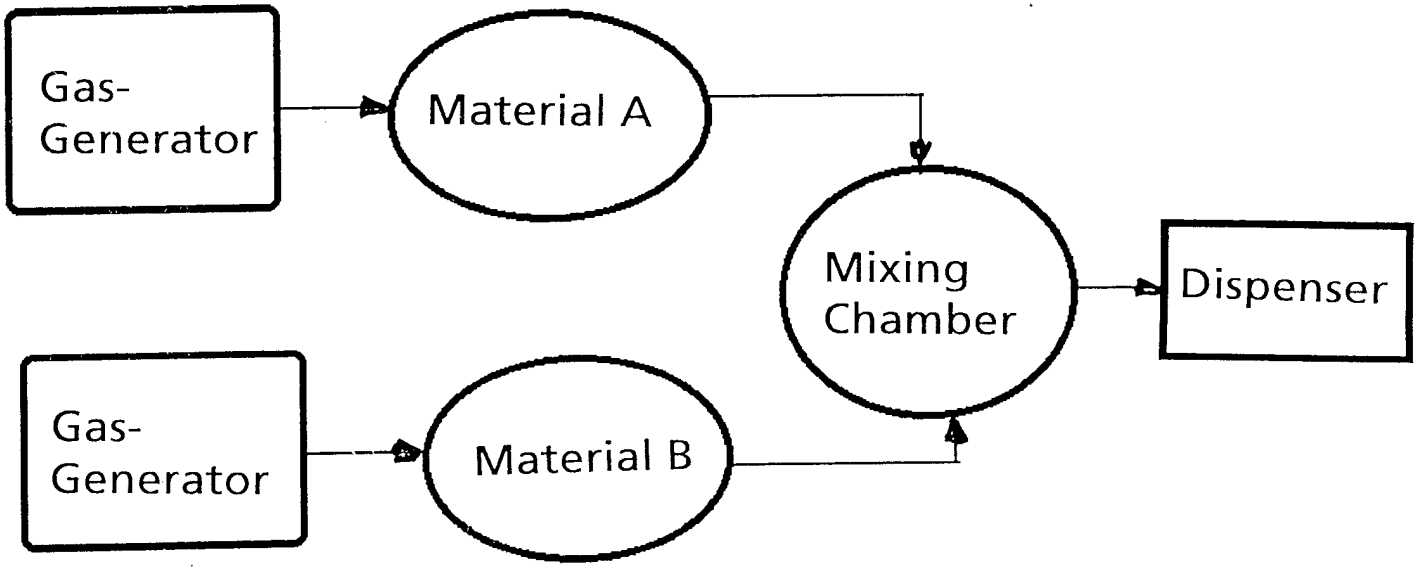
Super Critical Fluid Process (SCFP)



Carbon Dioxide

Gas Generator-Process



Basic-Technologies

- Solvent-Process
- Super Critical Fluid-Process (SCFP)
- Reaction Injection Moulding (RIM)
- Gas Generator-Process

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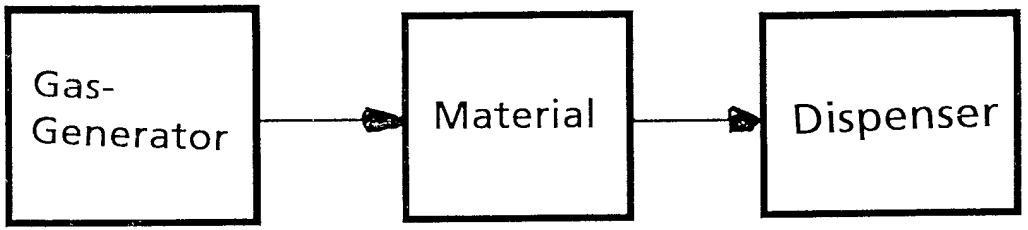
Gas Generator-Process



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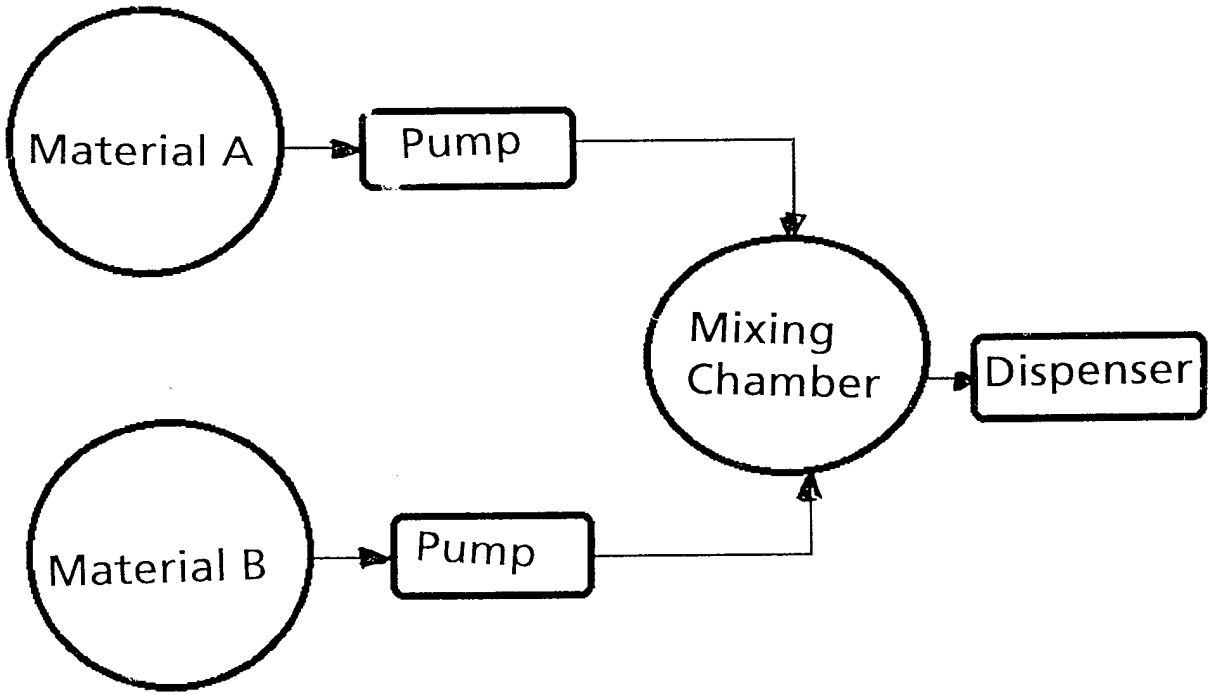
Reaction Injection Moulding (RIM)



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Technology	Material	Application
->Solvent-Process	Thpl & Elast.	Foams
->Super critical Fluid Process (SCFP)	PU/R/,.....	Entanglements, Foams,
->Reaction Injection Moulding (RIM)	PU/R/, PA/R/,PES/R/ PU/R/	Entanglements Foams

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Technology	Material	Application
->Gas Generator-Process	PU/R/, PA/R/	Entanglements
	PU/R/	Foams
	Phenolic Resin/R/	Foam
->Not expanded Spheres-Process	Thermoplastics	Foam in Bag
->One Component Process	Cyanogen Acrylate	Entanglements

Applications recommended by FINABEL

Technology	Crowds	Terrorists	Soldiers	Immobilization of Vehicles	Electronics
Infra Sound	⊗				⊗
Foams	⊗	⊗			
Entanglements	⊗	⊗	⊗	⊗	

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Applications recommended by AGARD-AAS 43

Technology	Large Crowds	Personnel in Foxhole	Roman Bridge
Infra Sound	⊗		
Foams	⊗	⊗	⊗
Entanglements	⊗		

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Examples of potential Carrier Systems

Technology	Helicopter	Missile	Land Craft	Person
RIM	⊗	---	⊗	---
Gas-Generator	X	⊗	X	⊗
SCF	X	---	X	X
Solution	X	---	X	X

⊗ especially favourable

X favourable

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Examples of Combined Technologies

Strategy	material	immaterial	material/immaterial
Simultaneous	IP / ET	IS / SS	IP / IS
One after another	CW / IG	IS / HPM	SF/ IS
Some Peaks	CW / IG	IS / PE	IG/ PE

IP: Irritant Particles; IG: Irritant Gas/Spray; IS: Infra Sound;

SS: Super Sonic; CW: Coloured Water; HPM: High Power Micro Waves;

SF: Sticky Foam; ET: Entanglement; PE: Pulsed Energy;

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Usual Foams

⇓

Foams which fill up Bags

⇓

Biodegradable Foams

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