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to AMITY A.Ş.

Chemical-Physical-Mechanical Properties of TOCK*

The technical analysis of TOCK (chemical mixture placed inside a module) brought by **AMITY A.Ş.** is carried out in Research Laboratories of Department of Chemistry, Faculty of Arts and Sciences, Middle East Technical University.

Sample brought: A Rock Breaking Module registered as a trademark "TOCK" that has a composition covering chemicals and non-hazardous ingredients in powder form, known by me within the scope of an NDA (non-disclosure agreement).

Examinations/Tests and Results: The following tests and examinations were conducted on TOCK Chemical Mixture and Module; the following observations and results on the chemical and physical properties and consequences and also on the Module are given below;

Chemical, Physical and Mechanical Properties of TOCK mixture and Module

Definitions	Result and/or Explanations	Comments	Standard testing method if any
A) CHEMICAL and PHYSICAL Properties of TOCK Chemical Mixture			
Appearance, color and odor	Fine light brown powder		
pH a) pH of water soluble part b) pH of the solid after use	a) pH= 7 b) pH=8	a) pH was determined in water soluble part the solid powder left in water for 24 h. b) pH of aqueous solution of the remained part after the reaction ceramic crucible.	



Flammability	Non- flammable at room temperature and higher temperatures	The material is not flammable in open flame for short times. However, when ignited by an outside source, it gives an exothermic reaction with a bright light at around 450-500°C. It burns with a fast cracking sound in a very short time.	
Self-Igniting property	No self –igniting property	-----	
Explosivity – BAM Fall hammer (Impact)	No explosive property	The impact energy up to max. level of 50J was applied and no explosion was observed. Besides, the material was compressed by 5000 psi (320 atm) and no observable change has been recorded. This 50J level is far more above limiting energy (safe limit)	UN Handbook Test series 3. Type 3(a) STANAG 4489
Explosivity – BAM Friction	No explosive property	Material is tested up to 110 N friction load and no explosion or burning was observed. This friction load is above the limiting force to be applied (safe limit)	UN Handbook Test series 3. Type 3(b)
Oxidative property	It has no oxidative property in its solid state. It is fairly a strong oxidant in humid and aqueous media for most of the metals.	Because of its ingredients, in humid and aqueous media it oxidizes and rusts the metals (chromium, nickel, copper and iron etc.).	
Effect of Electricity	No change was observed by application of city voltage and current.	No change, burning or explosive kind, was observed upon applying 220 volts city potential and 10 ampere current.	
Vapor Pressure	None	-----	
Density (kg/m³)	Powder material has a bulk density of 1000±50 kg/m ³	-----	
Solubility	Material is partially soluble in water but insoluble in oils and other solvents.	-----	
Viscosity	none	-----	
Hygroscopic properties	Solid material has capacity to absorb water and water vapor. The material must be stored dry.	The solid cakes in 100 % humid medium in 72 h and dries very slowly at room temperature. The caking causes the loss of easy flow solid powder.	
Melting point	None	-----	



Shelf life	The minimum shelf life is three (3) years, in its original Module, dry medium (60% or less relative humidity).	Shelf life can extend to 5 or more years if it is kept well dry.	Recommended by the manufacturer
B) PHYSICAL and MECHANICAL Properties of TOCK Module		Modules are produced from HDPE with anti-static and biodegradable additives	
Impact test (10J)	No break or major damage on the module	PE material is known as one of the resistant materials against any kind of impact.	DIN EN ISO 179 ASTM D256
Drop test	Samples of TOCK Module with 400 gr. TOCK chemical dropped from 3, 6 and 12 m. height by free falling.	No break and any fracture were observed on TOCK Module.	ASTM D2463 UN Handbook Test series 4. Type 4(b)
Water Resistance	The samples of TOCK Module was left in water tank for 6, 12 and 24 h.	No water was found to leak into the inside of module. Chemical mixture was found to be free from water. Besides, HDPE does not absorb any water so does not allow any penetration inside to decompose the TOCK chemical.	ASTM D570 ISO 62
EFFECT OF WEATHER -20 C / + 60 C	Module is placed in fridge and oven to see the reaction	The melting limits of HDPE is around 125 °C Then, keeping the upper limits of usage below 125 °C is essential to avoid any deformation of the module. TOCK Modules should not face any continuous cold and hot media below – 20 °C and over +60 °, respectively, more than 6 hours.	These limits are recommended by the manufacturer.
EFFECT OF DIRECT FLAME or FIRE on MODULE	Modules are made of HDPE with anti-static and biodegradable additives. HDPE has melting limit of 125 C and ignition limit of 349 C.	Keep away from heat sources above 300 °C (to be on the safe side) and away from continuous direct flame and fire. Besides, to avoid melting of the HDPE Modules, avoid keeping them above 100 °C.	UL 94 HB
HARDNESS OF MODULE	The modules are produced from HDPE	Shore D is 70	



ARC RESISTANCE	No effect of electric arc of 10 mAmp and 10000 V	The Module body is encountered with arc electrodes and no effect is observed	ASTM D495 DIN IEC 61621
C) CLASSIFICATION Tests according to ADR and UN Handbooks		The tests are done according to the procedures and definitions given in the UN Handbook. Considering the product specifications, the target was to observe whether it falls in Class 5.1 (Sect. 34) as oxidizing substance.	UN Handbook – Section 34.
Test Method for Oxidizing Substances Test O.1 for oxidizing solids	Tests to observe Division 5.1 and Packing Groups; I – II – III	The tests are done according to the procedures and definitions given in the UN Handbook, Section 34.4 Results proved that; TOCK falls in; Class (Div.) 5.1 – Packing Group II or III	UN Handbook – Sub Section 34.4
UN Code designation	Search and evaluation of tests According to ADR and UN Handbooks;	Considering test results, product specifications; UN Code is given as; UN3085 – oxidizing solid, corrosive – n.o.s.	ADR and UN Handbooks (related sections)
D) TEST SERIES 2 Tests to observe the insensitivity of TOCK for excluding from Class 1	Tests according to the UN Handbook – Section 12	TOCK to be excluded from Class 1, 3 tests given in this section must give negative "-" results.	UN Handbook Sect. 12
Test Code/Name 2(a) Gap test 2(b) Koenen test 2(c) Time/pressure test	These 3 tests are the essential ones required to observe a chemical product to be in or out of Class 1 (as per ADR and/or UN Handbooks)	These 3 basic tests have been carried out according to the specifications and standards given in the related section, using the devices and apparatus manufactured as per the given specs and dimensions. Results of these 3 tests showed negative outputs for TOCK, which means, TOCK came out to be a product defined out of Class 1.	

(*) TOCK is the trademark of a system, defined as "electronically activated chemical rock breaking system"
Module with chemical mixture inside is a part of this system.

Sincerely,

Prof. Dr. Teoman Tincer

Sept. 2022