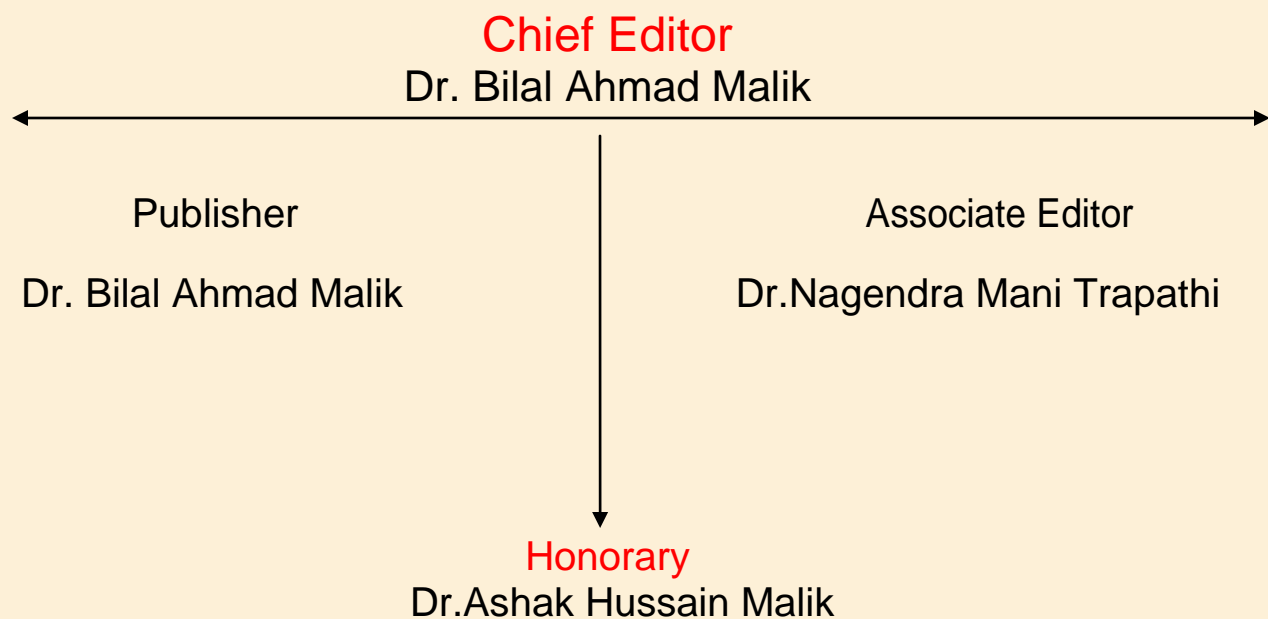


North Asian International Research Journal Consortium

North Asian International Research Journal

Of

Science, Engineering and Information Technology



NAIRJC JOURNAL PUBLICATION

North Asian
International
Research Journal Consortium



Welcome to NAIRJC

ISSN NO: 2454 -7514

North Asian International Research Journal of Science, Engineering & Information Technology is a research journal, published monthly in English, Hindi. All research papers submitted to the journal will be double-blind peer reviewed referred by members of the editorial board. Readers will include investigator in Universities, Research Institutes Government and Industry with research interest in the general subjects

Editorial Board

M.C.P. Singh Head Information Technology Dr C.V. Rama University	S.P. Singh Department of Botany B.H.U. Varanasi.	A. K. M. Abdul Hakim Dept. of Materials and Metallurgical Engineering, BUET, Dhaka
Abdullah Khan Department of Chemical Engineering & Technology University of the Punjab	Vinay Kumar Department of Physics Shri Mata Vaishno Devi University Jammu	Rajpal Choudhary Dept. Govt. Engg. College Bikaner Rajasthan
Zia ur Rehman Department of Pharmacy PCTE Institute of Pharmacy Ludhiana, Punjab	Rani Devi Department of Physics University of Jammu	Moinuddin Khan Dept. of Botany Singhaniya University Rajasthan.
Manish Mishra Dept. of Engg, United College Ald.UPTU Lucknow	Ishfaq Hussain Dept. of Computer Science IUST, Kashmir	Ravi Kumar Pandey Director, H.I.M.T, Allahabad
Tihar Pandit Dept. of Environmental Science, University of Kashmir.	Abd El-Aleem Saad Soliman Desoky Dept of Plant Protection, Faculty of Agriculture, Sohag University, Egypt	M.N. Singh Director School of Science UPRTOU Allahabad
Mushtaq Ahmad Dept.of Mathematics Central University of Kashmir	Nisar Hussain Dept. of Medicine A.I. Medical College (U.P) Kanpur University	M.Abdur Razzak Dept. of Electrical & Electronic Engg. I.U Bangladesh

Address: - Dr. Ashak Hussain Malik House No. 221 Gangoo, Pulwama, Jammu and Kashmir, India - 192301, Cell: 09086405302, 09906662570, Ph. No: 01933-212815,

Email: nairjc5@gmail.com, nairjc@nairjc.com, info@nairjc.com Website: www.nairjc.com

BLADELESS GRAVITY MIXER

**MR. P. S. KUMBHAR¹, MR. R. S. KAPSE², SURWASE PRASHANT³, SURYAWANSHI GANESH³,
RAHUL SINGH³ & PAIGUDE PRATHAMESH³.**

¹ Scientist 'F', Joint Director, High Energy Materials Research Laboratory (HEMRL, DRDO Pune,) Pune

² Scientist 'D', HOD, MED, High Energy Materials Research Laboratory (HEMRL, DRDO Pune,) Pune

³ Project Research Students, Department of Mechanical Engineering, AISSMS's COE Pune

1. ABSTRACT:

A mixer for particulate material has a cylinder supported for rotation about a substantially horizontal axis, the support means being adjustable for elevating its receiving end so as to be operated as a continuous mixer. It is known that particularly fragile materials which are not intended to undergo any inter granular destruction can be mixed in free-fall or gravity mixers, such as double-cone mixers. In such mixers it is only possible to adequately mix a batch by using very long mixing times. With certain materials which have a wide range of granule size and weight, these conventional mixers have even been known to promote disintegration. They are totally unsuitable for use as flow mixers.

Optimum amount of energy to be gain from the propellant this can be achieved by using high density materials. In conventional mixers blades are used which results in generation of undesirable heat so they are not suitable for high sensitive, high density propellants. In order to overcome this problem bladeless mixers are designed. This type of mixer is so designed that mixing of propellant and its additives is done under the influence of gravity.

Keywords: Mixer, Gravity, Bladeless.

2. INTRODUCTION:

A mixer is a machine for mixing things. Mixer has a cylinder supported for rotation about substantially horizontal axis for particulate material, the support means being adjustable for elevating its receiving end so as to be operated as continuous mixer. Free fan gravity mixer such as double cone mixer, particularly fragile materials which are not intended to undergo inter granular destruction can be mixed by using very long mixing time it is only possible to adequately mix a batch. Conventional mixers have been known to promote disintegration for certain materials which have wide range of granule size and weight.

For one specific application specific mixers are designed while other applications such as variable speed, changeable impellers and shafts plus a wide range of motor horsepower, more versatile mixers are designed.

3. TYPES OF MIXER:

3.1. Aerator: For biological waste treatment, a mixer or other device is used to dissolve air into water. Splashing at surface or by submerging with a pipe or with a sparge providing air to impeller it may be operated.

3.1.1. Advantages: No moving aerator parts, High oxygen transfer, High alpha factors, Minimal maintenance, Virtually silent operation

3.1.2. Disadvantages: Extended aeration plants do not achieve DE nitrification or phosphorus removal without additional unit processes, longer aeration period and hence requires more energy.

3.2. Air Mixer: A mixer with a motor which uses compressed air instead of electricity so sometimes called an air mixer or air drive mixer.

3.2.1. Advantages: The engine can be massively reduced in size. Low manufacture and maintenance costs as well as easy maintenance. Compressed-air tanks can be disposed of or recycled with less pollution than batteries.

3.2.2. Disadvantages: The principal disadvantage is the indirect use of energy.

3.3. Bottom Entry: At bottom head vessel drive is mounted for bottom entry type of mixer special type of shaft seal must be equipped.

3.3.1. Advantages: Entry through top-end cover of the reactor plate does not cause leakage of material, as the reactor is always under positive pressure during operation.

3.3.2. Disadvantages: This requires longer shaft length to reach almost to the bottom of the reactor and hence material requirement is more. Loss of power transmitted to the shaft is more.

3.4. Direct Drive Mixer: A direct drive has an output shaft which rotates at a same speed as the motor. They are relatively simple and offer a higher component of shear to the process.

3.4.1. Advantages: Increased efficiency: The power is not wasted in friction (from the belt, chain, etc. and especially, gearboxes.) , Reduced noise, Longer lifetime, High torque at low rpm.

3.4.2. Disadvantages: The main disadvantage of the system is that it needs a special motor.

3.5. Disperser Mixer: It is of special purpose high shear mixer or just blade or an impeller, It is a high speed device with sharp edges (some look like circular saw blades with bent teeth) to break up powders or particles so as to dissolve or suspend.

3.5.1. Advantages: fast mixing, low head room and dust-tight construction (or vacuum, if required).

3.5.2. Disadvantages: minimal clean-up, waste generation, storage and handling.

3.6. Flocculator: This mixer is used to enhance contact of particles in suspension to agglomerate them for easier settling or separation. It has relatively low rpm.

3.6.1. Advantages: They allow for space reduction and decreased structural mechanical costs.

3.6.2. Disadvantages: Single stage flocculators are susceptible to short-circuiting. The floc formation in the single stage flocculation chamber is more difficult to control.

3.7. Gear Drive: It is mixer with an output shaft that has a speed lower than motor speed because of gear reducer between motor and output shaft. It transmits high torque and has a higher pumping efficiency per horse power.

3.7.1. Advantages: They can hold large capacity. Belt-driven models tend to have variable speeds.

3.7.2. Disadvantages: They have fixed speeds.

3.8. Homogenizer: it is a very high speed mixer used to blend immiscible phases of a solution into cream or emulsion.

3.8.1. Advantages: They are fast and efficient and are capable of producing a fine droplet or particle size, typically in the range of 2 – 5 microns.

3.8.2. Disadvantages: Through homogenization, fat molecules in milk become smaller and become 'capsules' for substances that bypass digestion. Proteins that would normally be digested in the stomach or gut are not broken down, and are absorbed into the bloodstream.

3.9. Magnetic Drive Mixer: A magnet is used to drive impellor and shaft. Magnetic field is used to drive the internal mixer. The driven shaft does not penetrate vessel affording “seal less” mixing.

3.9.1 Advantages: They are easily cleaned and disinfected compared to the more laborious cleaning and disinfecting steps that must be performed by mixing tools with complex configurations.

3.9.2 Disadvantages: They are not suitable for highly viscous liquids.

3.10 Portable Mixers: With a ‘C’ clamp or adjustable plate mount the mixers are relatively easily mounted from time to time.

3.10.1. Advantages: Stand-alone mixer with more strength. It is easy to control the thugs of the path, and move their bowls to ensure no missed composition.

- 3.10.2. Disadvantages:** The motor is not so strong, so the hand mixer is really only the thinner, softer dough and batters.
- 3.11. Rotor Stator:** A rotating head or impellor inside a stationary shroud is used in this type of high shear mixer.
- 3.11.1. Advantages:** Its ability to disintegrate large particles and droplets in a single pass.
- 3.11.2. Disadvantages:** Intense shearing action, this one does not force manufacturers to choose.
- 3.12. Sanitary Mixers:** They are the ones whose drive components (motor, gearbox) are made from stainless steel or other approved materials. They are used in sanitary and wash down environments as well as in highly corrosive atmospheres.
- 3.12.1. Advantages:** The process performance is excellent; however they exhibit high pressure drops which often necessitate use of larger diameter mixers to minimize the impact of pressure drop.
- 3.12.2. Disadvantages:** These Medium Performance designs however require long lengths to create a reasonable degree of mixing.
- 3.13. Side-Entry Mixers:** : Side entry mixers are mounted on flange through side of tank. To reduce capital cost side entry mixers are used.
- 3.13.1. Advantages:** It is more intense and rapid blending, more capabilities for solids suspension, and generally more uniform mixing.
- 3.13.2. Disadvantages:** It is more expensive than a side-entry mixer (in appropriate situations), but will usually give better mixing.
- 3.14. Static Mixers:** Static mixers have no moving parts and have pipes with specially designed baffles which blend fluids as they flow. It is a precision engineered device for continuous mixing of fluid materials. The fluids to be mixed are usually liquid. They are also used to disperse gas into liquid or blend immiscible liquids. The loss in pressure as fluid flow through static mixer provides energy for mixing. One design of static mixer is plate type mixer and another common device types consists mixer elements contained in a cylinder (tube) or squared housing. Their diameters vary from 6 mm to 6 m. stainless steel polypropylene Teflon, PVDF, PVC, CPVC and polyacetal are the typical construction materials for static mixer components.
- 3.14.1. Advantages:** Zero maintenance, low cost, easy installation, and low energy consumption.
- 3.14.2. Disadvantages:** The mixing process is modular: the more difficult the application, the greater the number of elements required.

3.15. Top-Entry Mixers: Mixers mounted on the rim, on beams, or on a flange entering from the top of the tank.

3.15.1. Advantages: More intense and rapid blending, more capabilities for solids suspension, and generally more uniform mixing.

3.15.2. Disadvantages: More Expensive.

3.16. Planetary Mixers: For mixing of round products planetary mixers are used. Round products include adhesives, pharmaceuticals, food (including dough), chemicals, plastic and pigments, etc. under atmospheric or vacuum conditions these mixers are ideal for mixing and kneading viscous paste (upto 6 million centipoise). The available options include jacketing for heating or cooling or vacuum pressure or varying speed drives, etc. the blades each rotate on their own axes and at the same time on common axis hence providing complete mixing in a very short time frame.

3.16.1. Advantages: Easy cleaning, Small footprint, Semi-continuous operation, Lower cost.

3.16.2. Disadvantages: The mixer had no variable speed capability.

3.17. Banbury Mixers: It is named after inventor Fernley H. Ban bury, this mixer is a brand of internal bath mixers. 'Ban bury' is trademark owned by Farrel Corporation. For mixing or compounding rubbers and plastic these mixers are used. They consist of two rotating spiral shaped blades encased in segments of cylindrical housing. They intersect so as to leave a ridge between the blades. For circulation of heating or cooling, plates may be cored. Major labour and capital savings in tire industry, doing away with initial step of roller milling rubber are resulted from their inventions. It is also used for reinforcing fillers in resin system.

3.17.1. Advantages: It is use in Intermeshing and tangential rotor design mixers.

3.17.2. Disadvantages: High cost, tying up production capacity with less profit as the end result.

3.18. High Viscosity Mixers: Mixing materials with laminar mixing processes as the ingredients have high viscosities that a turbulent mixing phase cannot be done with high amount of heat. Putties, chewing gum and so require laminar mixing which can be done by high viscosity mixers. The end product usually starts at several hundred thousand centipoises and can reach as high as several million centipoises. Typical mixers used for this purpose are of double arm, double planetary or planetary disperser design. Features such as vacuum and jacketing to remove air and to control the temperature of mixture, various models are built.

3.18.1. Advantages: Ease of product charging, operation and discharging of material. The shape of the blender shell ensures complete discharge of product material. Particle size reduction is minimized due to the absence of moving blades, agitators.

3.18.2. Disadvantages: Problems occur with mixtures having a wide particle size distribution or large differences in particle densities. Highly cohesive materials cannot be handled.

4. LITERATURE REVIEW:

An essential requirement applying to every mixing operation is that both horizontal and vertical flow of sufficient intensity occurs and that all the material is moved frequently into the zone of intense mixing action. Stratification, settling and segregation of the material must not be allowed to take place. These phenomena are liable to occur as the result of gravity or centrifugal force and must be prevented by suitable mixing action.

4.1. Gravity Mixer:

Patent: 3666240, (United States), May, 30, 1972, GRAVITY MIXER, 1972.

A gravity mixing machine for free-flowing products in which a mixing drum is arranged inclined to the horizontal and rotatable about its longitudinal axis and into which the material is introduced at its higher end and discharged at its lower end. The drum is divided into a plurality of successive mixing chambers by the provision of radially extending plates. [1] It is an object of the invention to provide a gravity mixer by means of which even highly sensitive free-flowing materials with a wide grain size distribution can be mixed quickly, intensively and uniformly without suffering any damage in continuous operation.

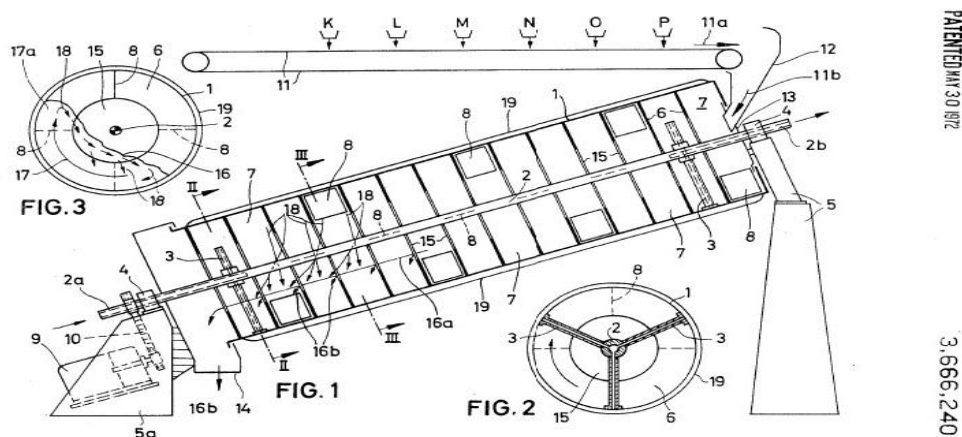


Figure No. 1: A schematic vertical longitudinal section through the gravity mixer as a whole.

Background of invention was that, the particularly fragile materials which are not intended to undergo any intergranular destruction can be mixed in free-fall or gravity mixers, such as double-cone mixers. In such mixers it is only possible to adequately mix a batch by using very long mixing times. With certain materials which have a wide range of granule size and weight, these conventional mixers have even been known to promote disintegration. They are totally unsuitable for use as flow mixers.

4.2. Rotary Gravity Mixer:

Patent: 4277185, (United States), July, 07, 1981, ROTARY GRAVITY MIXER, 1981. A rotary gravity mixer for inducing turbulence in a liquid preparation such as developing lacquer to produce a substantially uniform suspension of pigment within the liquid vehicle of the preparation is disclosed. A container of the preparation is held in eccentric relation within an open ended cylindrical carrier by a cylindrical clasp. [2] The carrier cylinder is received by a pair of roller bars which define a turn cradle for supporting the carrier cylinder for rotary movement. The open ended cylindrical clasp extends transversely through the carrier and is anchored to the carrier on opposite ends whereby its longitudinal axis is inclined with respect to the longitudinal axis of the carrier. The clasp is a relatively smaller diameter, cylindrical sidewall section which is severed along its length to permit the clasp to be spread upon to receive the container and which holds the container in resilient gripping engagement. Because the container is held in skewed relation with respect to the cylindrical carrier, turbulence is induced within the preparation which produces a substantially uniform suspension of pigment within the liquid vehicle of the preparation in response to rotary movement of the carrier.

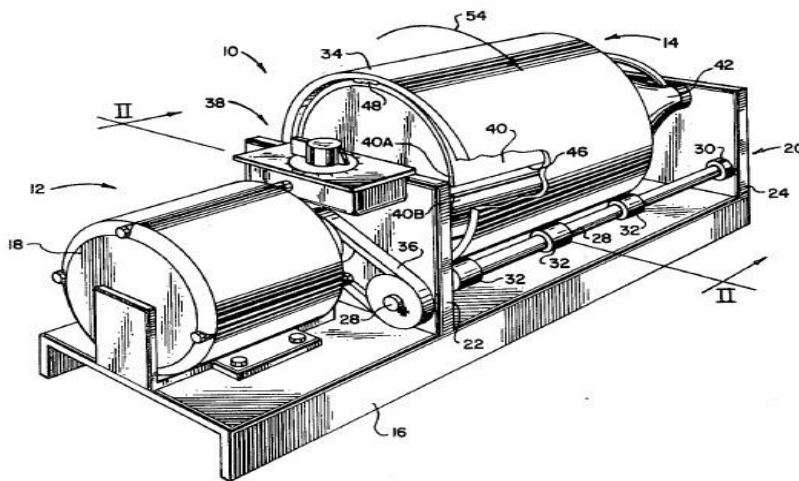


Figure No. 2: A perspective view of a rotary mixing appliance constructed according to the teachings of the invention.

The present invention relates generally to mixing appliances, and in particular to a rotary gravity mixer for producing a uniform dispersion of finely divided particles throughout an enclosed volume of liquid.

4.3. Sigma Mixer SM100 :

Sigma Mixer SM100 supplied by Unique Mixers and Furnaces Pvt. Ltd to ISRO Sriharikota, these are designed for Explosives and for composite Propellants.

The **mix composition of explosives and composite propellants** includes substances such as inorganic salts, metal powders, organic crystals, special solid additives and a minor quantity of liquids.[3] Explosives are classified depending on the type of hazard that they possess in conditions of storage, confinement, process of manufacture and during processing at elevated temperature and pressure, besides other special considerations. The type of hazards include-Mass explosion hazard, serious projectile hazard, Fire hazard, minor blast or projectile hazard, Fire or slight explosion hazard.



Figure No. 3: Sigma Mixer SM100 supplied by Unique Mixers and Furnaces Pvt.Ltd to ISRO Sriharikota.

Due to the explosive characteristics and their high viscosity, these materials offer several mixing challenges. Mixing is to be carried out in a controlled environment and with utmost care. The equipment used for mixing has therefore to be designed so as to provide the right conditions for mixing and to prevent any type of explosion hazard during the mixing process. The horizontal sigma blade kneader and the vertical planetary mixer are the most popular equipment used for mixing of explosives and propellants.

Mixer operation during a test requires the regulation of its internal pressure, exit mass flow, and exit temperature. A mathematical model is developed to facilitate subsequent controller designs. The model must be simple enough to lend itself to subsequent feedback controller design, yet its accuracy must be tested against real data. For this reason, the model includes function calls to thermodynamic property data. [4] Describes the modeling and control of a mixing chamber used in rocket engine testing in NASA. The mixer must combine high pressure liquid hydrogen and gaseous hydrogen to produce the output flow.

5. CONCEPT OF BLADELESS GRAVITY MIXER:

The term Bladeless Gravity Mixer describes gravity mixing by means of which even highly sensitive free-flowing materials with a wide grain size distribution can be mixed quickly, intensively and uniformly without suffering any damage in continuous operation. The mixer is also eminently suitable for cooling or heating mixing stock. To this end, it is provided with a double jacket with inflow and outflow facilities, for example in the form of bores in the shaft and in spokes which support the drum of the mixing vessel. Compared with conventional mixers, cooling and heating are much more intensive in this mixer because this mixer is comparable with a radiator in so far as, in addition to the wall of the mixing vessel, the plates incorporated to divide the mixing vessel into small mixing chambers and the entraining plates in the mixing chambers also communicates the temperature of the cooling or heating medium to the material being mixed. In addition, there are no moving mixing tools to counteract cooling through friction with the material being mixed.

The bladeless gravity mixer is required for homogeneous mixing of propellant and its additives. Bladeless gravity mixer, in which the container is constantly rotated, so that the material inside is tumbled about. The overall movement of material will follow the pattern of letter 8 inside a mixing vessel to give a perfect mix of propellant.

In many cases some kind of physical change of the materials concerned is required to take place during mixing, that is heating, cooling, dissolving, aeration, desecration, change of state(liquid to solid or vice versa), granulation, dispersion (suspension, emulsion), wetting, colouring, change of viscosity, etc.

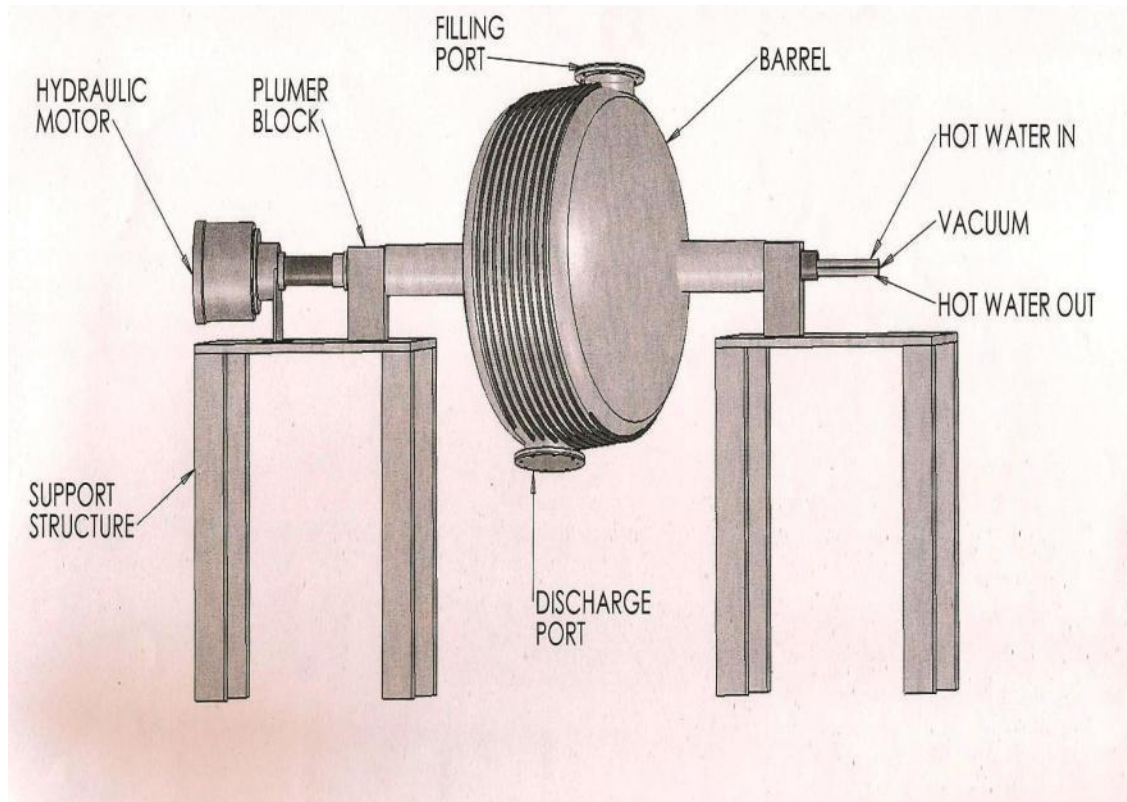


Figure No. 4: Block Diagram of Bladeless Gravity Mixer.

Bladeless Gravity mixers are employed for mixing of material which must not be subjected to the severe mechanical stresses exerted by mixing elements. Also, it is absolutely necessary to avoid any abrasive action of propellant with blade or wall of the mixing vessel. Therefore it is highly recommended to avoid any rotary blades or mechanical rotary, joints or baffles in mixing bowl assembly. Thereby it was decided to complete the mixing operation using bladeless mixer

Bladeless gravity mixer will consist of a mixing vessel inclined at an angle of 30 degrees. The mixing vessel will be filled its $1/3^{\text{rd}}$ of the maximum capacity. Now, when vessel is rotated at 30-40 rpm on a shaft inclined at an angle of 30 degrees, the viscous material inside vessel will limb along the wall of vessel and fall under the influence of gravity. The overall movement of material will follow the pattern of letter 8 inside a mixing vessel to give a perfect mix of propellant. The overall capacity of gravity mixer will be 250 liters. In means 70-80 kg of

propellant can be easily processed in this mixer. The mixer will be provided with material inlet and outlet port which also facilitate cleaning process of mixing bowl. The complete mixing bowl will be cascaded in a hot water bath jacket to facilitate effective mixing bowl will be cascaded in a hot temperature. This feature of Gravity mixer will make it unique and adoptable for different range of product. To achieve effective working of gravity mixer many mechanical components like rotary joints for supply of hot water, temperature sensing and controlling unit, vacuum gauges for vacuum measurement inside the vessel, Plummer block, prime movers, various controllers, fasteners, etc.

To ensure that the material to be mixed is kept in motion inside the mixing vessel from the feed opening to the outlet, the mixing vessel is preferably inclined at an angle of from to 30° to the horizontal. It is designed to rotate at such a speed that the material being mixed is not subjected to any centrifugal forces of sufficient magnitude to impede the downward trickling of the material being mixed. To this end, a drum with an internal diameter of 600 mm is advantageously driven at 0 to 40 r.p.m.

Industrial mixers and blenders are used to mix or blend a wide range of materials used in different industries including the food, chemical, pharmaceutical, plastic and mineral industries. They are mainly used to mix different materials using different types of blades to make a good quality homogeneous mixture. Included are dry blending devices, paste mixing designs for high viscosity products and high shear models for emulsification, particle size reduction and homogenization. Industrial mixers range from laboratory to production line scale.

They can operate at different temperatures and pressures for mixing different solutions and can also have internal or external heating systems added to them. Options also exist where spray nozzles, CIP, PLC and pneumatic or electric systems can be used. Systems can come equipped with hydraulic or electronic soft start mechanisms so that they start and stop smoothly.

In addition to performing typical batch mixing operations, some mixing can be done continuously. Using a machine like the Continuous Processor, one or more dry ingredients and one or more liquid ingredients can be accurately and consistently metered into the machine and see a continuous, homogeneous mixture come out the discharge of the machine. Many industries have converted to continuous mixing for many reasons. Some of those are ease of cleaning, lower energy consumption, smaller footprint, versatility, control, and many others. Continuous mixers, such as the twin-screw Continuous Processor, also have the ability to handle very high viscosities.

6. PARAMETERS:

6.1. CAD Assembly of Bladeless Gravity Mixer:

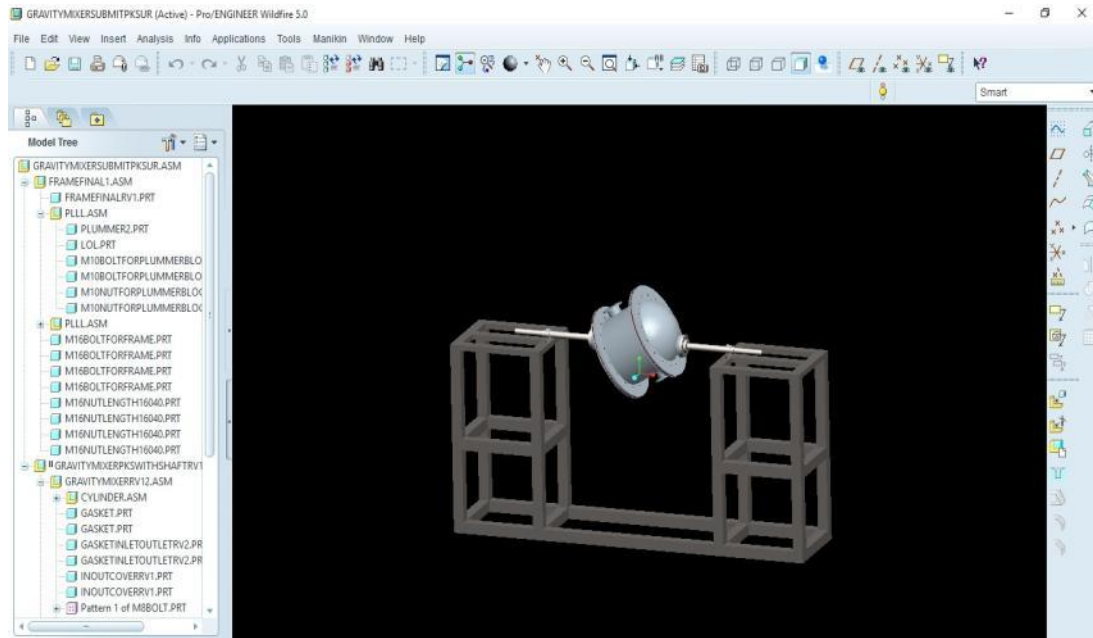


Figure No. 4: 3D CAD Design of Bladeless Gravity Mixer.

6.2. Working:

- Bladeless gravity mixer model is little bit similar to that of a cement mixer as they both have an offset along the horizontal axis.
- The basic idea is to have the ingredients move in barrel shapes container unit where they will mix with each other due to their motion caused by gravity.
- The main purpose of using this construction is to avoid the use of blades or any other part which may cause friction.
- The barrel is rotated using a hydraulic motor at speed 0-40 rpm.
- The mixing action of the ingredients is due to the offset angle.

6.3. Advantages:

- Quick and easy Operation.
- Homogeneous mixture is produced with the help of Bladeless Gravity Mixer.

- Blades are not used in Bladeless Gravity Mixer therefore friction is avoided.
- Less maintenance cost.
- Operation cost is less.
- Any size and shape of ingredients can be mixed with the help of Gravity Mixer.

6.4. Disadvantages:

- Cost of hydraulic motor is more than electric motor.
- Time required for the process is more.
- During the process vibration is produced.

6.5 Application:

- As the name indicates, 'Bladeless Gravity Mixer' it is bladeless because the material which has to be mixed is very sensitive so friction is avoided.
- The Bladeless Gravity Mixer is especially designed for very sensitive materials ingredients which have to mix.

7. CONCLUSION:

The Abrasive work is reduced due to absence of blades and baffles and this leads to reduction in heat generation and increased safety level.

8. ACKNOWLEDGMENT:

The students working under team of Mr. P. S. Kumbhar and Mr. R. S. Kapse would like to thank them and to the laboratory of High Energy Materials Research Laboratory (HEMRL) Pune where this work was performed under project “Stress Analysis of Bladeless Gravity Mixer”. Students would also like to thanks our college project guide Prof.P.S.Aglawe and entire team of AISSMS COE, Pune.

9. REFERENCES:

1. 3666240, (United States), May, 30, 1972, GRAVITY MIXER, 1972.
2. 4277185, (United States), July, 07, 1981, ROTARY GRAVITY MIXER, 1981.
3. Dr. S.D.Dawande 1999, "Process Equipment Design", First Edition, Central Techno Publication, Nagpur, India.
4. Hanz Richter, Enrique Barberi and Fernando Figueroa., Modeling, Simulation and Control of Propellant Mixer, *Int. Journal of Elsevier Inc.*, 2004, 18(10), pp. 1-1.

Publish Research Article

Dear Sir/Mam,

We invite unpublished Research Paper, Summary of Research Project, Theses, Books and Book Review for publication.

Address:- Dr. Ashak Hussain Malik House No-221, Gangoo Pulwama - 192301

Jammu & Kashmir, India

Cell: 09086405302, 09906662570,

Ph No: 01933212815

Email:- nairjc5@gmail.com, nairjc@nairjc.com , info@nairjc.com

Website: www.nairjc.com

