Performance of Mass & Energy Balance of VEN

Internship Report

Submitted for the partial fulfillment of the degree of

Bachelor of Technology

In

Chemical Engineering

Submitted By

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0901CM201027

UNDER THE SUPERVISION AND GUIDANCE OF

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MADHAV INSTITUTE OF TECHNOLOGY & SCIENCE, GWALIOR (M.P.), INDIA
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Jan – May 2024

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I hereby declare that the work entitled **"Performance of Mass & Energy Balance of VEN"** is my work, conducted under the supervision of **Prof. Anish P. Jacob, Assistant Professor & Coordinator,** during the session Jan-May 2024. The report submitted by me is a record of bonafide work carried out by me.

I further declare that the work reported in this report has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma in this institute or any other institute or university.

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Date: 24th May 2024
Place: Gwalior

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teva | api

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To whom so ever it may concern

This is to certify that **Mr. Priyanshu Sharma** a student of Madhav Institute of Technology & Science, Gwalior (M.P.) has undergone a Training with us, on **"Mass and Energy Balance"** from **18.01.2024 to 18.05.2024**.

During the tenure of his training, he was found to be sincere and hard working.

wish him all the best for his future endeavors.

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PLAGIARISM CHECK CERTIFICATE

This is to certify that I/we, a student of B.Tech. in *Department of Chemical Engineering* have checked my complete report entitled *"Performance of Mass & Energy Balance of VEN"* for similarity/plagiarism using the "Turnitin" software available in the institute.

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The full plagiarism report along with the summary is enclosed.

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ABSTRACT

The invention, manufacturing, and distribution of medications for a variety of medical conditions are all part of the vital pharmaceutical industry. By heavily spending in R&D to discover and improve medicines, the sector significantly contributes to the advancement of healthcare. Among the various drugs produced by the pharmaceutical industry is DVF, a potent depression reducing that is mostly administered to patients suffering from high depression. By bringing serotonin and nor epinephrine back into balance in the brain, desvenlafaxine, a serotonin-nor epinephrine reuptake inhibitor (SNRI), can lessen depressive symptoms. It is a valuable option for the treatment of depression because to its efficacy and safety profile; nevertheless, like with other medications, it must be administered correctly and under medical supervision.

Keywords: **Pharmaceutical Industry, Healthcare advancement, Mass Balance, Process Flow Diagram, Medications, Antidepressant, Equipment, Conservation of Mass**

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PRIYANSHU SHARMA

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ACRONYMS

1.	**ANFD : Agitated Nutsche Filter and Drier**
2.	**ANF : Agitated Nutsche Filter**
3.	**SF : Sparkle Filter**
4.	**NF : Nutsche Filter**
5.	**API : Active Pharmaceutical Ingredient**
6.	**R : Reactor**
7.	**V : Vessel**
8.	**SSHL : Stainless Steel Halar**
9.	**SS316 : Srainless Steel**
10.	**MSGL : Mild Steel Glass Lined**

NOMENCLATURE

1.	Δp	Pressure drop
2.	L	Length of Bed
3.	μ	Fluid Viscosity
4.	ϵ	Porosity
5.	Dp	Diameter of Particle
6.	v	Superficial Velocity
7.	ρ	Density of Fluid
8.	m	Mass
9.	Cp	Specific heat capacity of substance
10.	Q	Heat Added or Removed from the system
11.	Δt	Temperature difference

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CHAPTER 1: INTRODUCTION

1.1 About VEN

An intermediate of the pharmaceutical medication DVF is called VEN. The medicine is taken orally and is delivered gradually into the body over time in the form of extended-use tablets. DVF tablets are marketed under the common brand PQ. It is also offered as a generic medication. Most of the time, generic medications are less expensive than name-brand ones. Major depressive symptoms, such as sorrow and low energy, are treated with DVF. This medication is used to encounter depression. DVF belongs to the class of drugs known as SNRI.. It works by supporting the appropriate balance of serotonin and norepinephrine in the brain. Some studies conducted and it shown that VEN is useful in PTSD, also it can be used to treat chronic pain. Some of the common side effects include insomnia, sweating, dizziness and depressive disorders. Sometimes in SNRI class serotonin withdrawal is there, it can have severe effect on later pregnancy and can harm the child. VEN was approved by USA back in 1993, but at that time VEN was only available as Generic drug.

1.2 Clinical Data

Molecular wt.: 277.402 g/mol

Formula: $C_{17}H_{27}NO_2$

Chemical Safety: Irritant

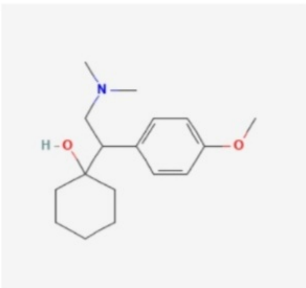

Figure – 1: Source: PubChem: VEN CID

1.3 Mass & Energy Balance

In many scientific and technical fields, mass balance and energy balance are basic ideas that are used to analyze and comprehend the behavior of systems, from chemical reactors to environmental ecosystems. In addition to offering important insights into operations, effectiveness, and environmental effects, balances are crucial for guaranteeing the conservation of mass and energy within a system. In this thorough investigation, we examine the concepts of mass balance and energy balance, clarifying their importance, uses, and relationships. Matter cannot be generated or destroyed, according to the rule of conservation of matter. This gives rise to the idea of mass, and the law may be formulated as follows: the mass of the materials used in any operation remains constant. Now that the law is acknowledged to be unduly restrictive for material travelling at almost the speed of light or materials undergo nuclear processes. In these conditions, mass and energy are mutually convertible, and their total is constant rather than equal to one. Nonetheless, mass and energy are believed to be independent in most engineering since this transfer is too little to be seen. Materials entering any process must either accumulate or exit the process in order to preserve matter.

The concept of energy balance, on the other hand, is based on the idea that energy can only change forms within of a closed system and cannot be generated or destroyed. Monitoring the movement of energy into, out of, and within a system is necessary for maintaining energy balance. Meaning there is no change in the overall energy. In the domains of thermodynamics, heat transfer, and power production, this balance is essential for assessing heat transfer, thermodynamic processes, and energy conversion systems.

Many natural and artificial systems demonstrate how mass and energy balance is intertwined, with changes in mass frequently corresponding to changes in energy and vice versa. In chemical processes, for example, mass balance requires that the entire mass of reactants and products be equal, but energy balance makes sure that the total energy intake and output be equal, taking into account heat that is emitted or absorbed throughout the reaction.

CHAPTER 2: LITERATURE SURVEY

Fraga, Eric S. et al. [2016] the topic of this research paper is "Process Analysis: The Significance of Mass and Energy Balances." It addresses the use of mass balances in steady-state reactive systems and non-reactive systems, as well as applications of mass balances in several instances with solutions, including multi-reaction issues with yield, selectivity, and conversion calculations needed.

David Pritchard et al. [2021] the topic of this research paper is "Calculations for the mass and energy balance in plant design." It addresses the application of energy and mass balance throughout the whole plant.

S. Nandagopal Nuggenhalli et al. [2023] this research paper examines "Mass and Energy Balances" as its subject. In addition to covering analysis based on the fundamental principles of matter and energy conservation, it investigates how the equations representing these. It is possible to apply conservation laws.

Baertschi, Steven W. et al. [2013] the study "Assessing mass balance in pharmaceutical drug products" is presented in this research article. It discusses the several ways that mass balance may be expressed, measured, and assessed in connection with chemical breakdown.

Am Ende, David J., et al. [2019] the topic of this research paper is "Analytical Aspects for Determination of Mass Balances." It includes details on what has to be done to guarantee that the data generated—by an engineer or an analyst—is of the greatest calibre. Necessary for a certain investigation. Explains the common mistakes that might skew analytical findings, the limits of each analytical approach, how to overcome them, and how to integrate analytical methods together.

Starzak, Maciej, et al. (2015) the study "Mass and Energy Balance Modeling of a Sugar Mill" is included in this research paper. It discusses integrated procedures to determine the ideal range of goods and the most efficient manufacturing routes, and SNRI's strategy is a case study of simulating pre-selected plant topologies, incorporating mass and energy balances for each of the biorefinery's constituent components.

Rizvi and associates [2024] "Mass and Energy Balances in Food Engineering Principles and Practices" is the subject of research in this case. It includes product creation, waste reduction, and industrial operation analysis in the field of food engineering.

Lieberman, Daniel Z. et al. [2009] "Desvenlafaxine in major depressive disorder: an evidence-based review of its place in therapy" is the topic of this research article. This substance is a serotonin norepinephrine reuptake inhibitor (SNRI) and is the active metabolite of venlafaxine.

An inhibitor of serotonin-norepinephrine reuptake (SNRI) Major depressive disorder (MDD) is treated with the well-known antidepressant medication DVF. Through the regulation of serotonin and norepinephrine levels in the brain, DVF lessens the symptoms of depression and improves mood. A medication's pharmacological profile and thorough instructions on dosage, administration, and potential side effects are crucial for its successful usage in the treatment of depression. [3]

Examined are DVF's safety and efficacy in treating MDD. Clinical evidence indicates that DVF can help patients feel better overall and reduce symptoms of depression. Nausea and vertigo are common side effects of the medicine, and significant adverse reactions require careful monitoring. Despite these concerns, DVF is a valuable option for treating depression due to its shown effectiveness. [4]

Beyond its impacts on individual patients, DVF also has an impact on society at large. When their condition is properly managed, MDD patients can have improved quality of life and more productivity. The medication also contributes to reducing the stigma that society places on mental health problems. All things considered, DVF makes a major contribution to the treatment of mental disease and encourages more research and development in the field. [4]

CHAPTER 3: COMPANY'S PROFILE

Teva pharmaceutical industries comprises, Teva API as an independent company. Teva pharmaceutical industries is the world's largest maker of generic medications and ranks in the top 15 pharmaceutical enterprises in the world [6]

The establishment of Asia, a business focused on the manufacturing of veterinary and pharmaceutical chemicals, in 1935 marked the beginning of Teva API's illustrious history. Teva API has built and acquired prestigious production and research facilities all throughout the world over the years. A thorough integration programmed is implemented at each plant to ensure compliance with the company's best practices and high standards. [6]

Teva API now runs 6 R&D facilities and 15 manufacturing facilities worldwide. Every site supports their continued success in customer service, production, and research & development. [6]

TEVA operates three world-class production facilities in India: one in Gajraula, Uttar Pradesh; another in Malanpur, Madhya Pradesh; and the third in Ambernath, Maharashtra. TEVA runs a plant in Malanpur District, Bhind, Madhya Pradesh, where it produces several APIs. Some of the API formed at Teva Malanpur Unit:

- Asthma
- Diabetic/ Non Diabetic
- Depression/ Feeling Sadness

3.1 Vision

Our goal is an industry that is always changing to be a leader and a mark of excellence. [6]

3.2 Mission

As a global leader in biopharmaceutical Teva's goal is to enhance the lives of patients. [6]

CHAPTER 4: PROBLEM FORMULATION

The design, analysis, and optimization of chemical processes depend heavily on the fundamental concepts of mass and energy balance in chemical engineering. In chemical engineering, mass and energy balances are crucial instruments that enable the effective, secure, and chemical process design and operation that is sustainable. They are essential to the industry's achievement of financial effectiveness, adherence to the law and creativity.

On the VEN, perform a general balance of mass and energy. In order to properly comprehend the mass and energy balance, list all of the equipment and procedures used.

CHAPTER 5: METHODOLOGY

5.1 Objectives

Determine the Material Balance of VEN, by considering all reactants, also including the recovery stream, products and by-products.

Calculate the Energy input at every step of the procedure of VEN, comprising cooling and heating

5.2 System Description

The production of VEN includes crucial key steps:

1. Inertization: Removing fire hazard by cutting the supply of oxygen.

2. Charging: Batch KRM is charged through glove box and Solvents through AOD pump.

3. Separation: Including Layer separation technique to remove the impurities in both aqueous and organic phase.

4. Discharge: Recovery of solvent and removing products..

5. Cleaning: Preparing the reactor for the next step of the procedure, generally reactor is cleaned with the same solvent used in the procedure.

5.1 Equipment for Filtration

5.1.1 Filtration

The process of filtering involves passing the mother liquor through a filter medium a substance that catches solid particles in order to remove the solid particles. The fluid is liquid, and the useful stream that comes out of the filter might be either liquid or solid depending on the requirements of the operation. [1]

A pressure difference across a filter media causes fluid to pass through it. As a result, filters are further divided into two categories: those that function with atmospheric pressure upstream and a vacuum downstream, and those that function with a pressure above atmospheric on the upstream side of the filter media. There are various ways can create pressures higher than atmospheric pressure. Centrifugal, hoover and pressure filters make up the majority of industrial filters. [1]

5.1.2 Principles of Filtration

One unique instance of flow via porous material is filtration. When a filter cake accumulates or the filter media is blocked, flow resistances in filtering gradually rise. The two most significant factors are the level of pressure drop across the component and the flow rate through the filter. During filtering, either the level of pressure drop or the flow rate gradually lowers over time. Less typically, constant-rate filtration is achieved by gradually increasing the pressure drop. A process called constant-pressure filtering allows the flow rate to gradually diminish while maintaining a constant pressure drop. [1]

The liquid when filtering cakes pass through the filter media and the cake's resistances in sequence. The only resistance present in clarifying filters, the resistivity of filter media is frequent in the first phases of filtering cake. Cake resistance starts out at zero and rises over time as filtering moves along. When the cake is cleaned after filtering, the resistances of the filter media are often minimal and both remain constant during the cleaning process. [1] The overall decrease in pressure at any one time is the sum of the pressure drops over the substance and cake. Assuming that the input pressure is pi, the output pressure is po, and the pressure at the cake-medium boundary is p'.

, $\Delta p = p_i - p_o = (p_i - p') + (p' - p_{o)} = \Delta p_c + \Delta p_s$

Where Δp = overall pressure drop

Δp_c = pressure drop over cake

Δp_s = pressure drop over substance

Depression in pressure during the procedure of filtering cake:

A general equation named Ergun equation employed to determine the pressure dip it include all flow regimes. [1]

As Stated,

$$\frac{\Delta p}{L} = \frac{150\ \mu v(1-\varepsilon^2\ )}{\varphi^2 Dp^2 \epsilon^3} + \frac{1.75 \rho v^2\ (1-\epsilon)}{\varphi \epsilon^3 Dp}$$

1. Centrifuge Filter

The force of centrifugation is used by a centrifugal filter to separate liquids. A centrifugal force greater than the force of gravity is produced by rotating the separator quickly. Denser particles, such solids and heavier liquids, are pushed towards the bowl's outside edge by this force. The principle behind how a centrifugal filter works is much the same as that of a conventional filter. Particles larger than the size of the pore are collected and confined to a specific region.. Because centrifugal forces are substantially higher than those of gravity, a centrifugal filter has the benefit of facilitating separation more quickly. The residue flows through the filter, and the particles collect on a membrane to create a "cake." via applying more centrifugation to the cake. [1]

Figure – 2: Source: India Mart

Centrifugal Filter

2. Nutsche Filter

A typical laboratory tool, Buchner Funnel used in industries is called Nutsche Filter. It can function both vacuum and pressure environments. The majorities of applications for modern Nutsche filters, which are frequently employed under pressure, are batch-oriented and include fine chemicals, dyes, medicines, and insecticides. These types of filters were developed in late 1980's. These sophisticated Nutsche Filters can handle many functions, such as filtering, washing cakes, reacting, and heat drying, all in one device. They have highly developed process control, which closely monitors variables like temperature, pressure, and phi. In particular, Nutsche Filters work great with combustible, poisonous, corrosive, and smellus chemicals. [1]

Nutsche filter are particularly suitable for applications that require:

- Safe management of dangerous products in a small floor area
- Control of temperature precisely
- Features to wash the slurry..

Figure – 3: Source: India Mart

Nutsche Filter

3. Agitated Nutsche Filter

An extensively utilized filtration method in industries including paint, dye, pharmaceutical manufacturing, and wastewater treatment is the Agitated Nutsche Filter (ANF). This kind of filter was developed to enable direct solids discharge into dryers while filtering under either vacuum or pressure in sealed containers, because of laws governing safety and environmental issues pertaining to solvent evaporation. Residues after a solvent. It is widely employed in specialty batel-oriented processes such paint production, wastewater treatment, dyeing, and the synthesis of fine and therapeutic compounds. [1]

Advantages of ANF:

- The capacity to filter under pressure or under vacuum.
- Less contamination of filter cake.
- Low solvent loss.
- Low manpower requirement.

Figure – 4: Source: India Mart

Agitated Nutsche Filter

4. Sparkler Filter

A much known filtering setup for filtering liquids in the beverage, chemical, pharmaceutical, and other sectors is the Sparkler Filter. The pressure feeding theory underlies its operation. Impurities are eliminated throughout the procedure and thereafter preserved as a compacted cake. The liquid is driven through many filter pads and filter plates after passing through the centre rod. The filter media that is resting on the filter plates collects suspended particles, and the clear filtrate comes out of the the bottom exit through the side holes in the tank's plate structure. Since the filter tank itself does not come into contact with the liquid, it stays clean. All of the cake solids and filtrates are contained in the completely closed container. [1]

Figure – 5: Source: India Mart

Sparkler Filter

5.2 Equipment for Drying

5.2.1 Drying

When a solid is being dried, it is frequently necessary to remove a very little amount of liquid in order to reduce the amount of liquid that remains to a level that is acceptable. Drying is typically the last stage of a process, and the product that comes out of a dryer is frequently prepared for final packing. Products with drier substances have different liquid contents; if a product has no liquid at all, it is referred to as completely dry material. [1]

5.2.2 Agitated Nutsche Filter Dryer

This kind of equipment is used to dry wet materials and separate liquids from solids. The ANFD is a commonly used apparatus for the solid-liquid separation, cleaning, and drying of many chemicals and medications. The cylindrical jar used in the ANFD contains a stirrer, and the jar's bottom is perforated. [5]

The ANFD operation involves the following steps:

1. Loading: The wet material to be dried is put into the vessel through the top manhole. [5]

2. Filtration: After that, the slurry is stirred and a vacuum is created under the filter material by the stirrer. Once the liquid has gone through the filter media, it is collected in the vessel. [5]

3. Washing: After filtering, the solid material in the vessel is washed with appropriate solvent in order to remove impurities. [5]

4. Drying: After washing, the solid cake is dried with a stirrer using heat or a vacuum. The solvent evaporates, leaving behind a dry, solid cake. [5]

5. Discharging: After the dry cake has completed drying, it is taken out of the vessel via the bottom discharge valve. [5]

Compared to other filter types, the ANFD offers a number of benefits, including as high filtering efficiency, less product loss, faster processing, and a closed system that removes the possibility of product contamination. The equipment is well-liked as it is simple to maintain and clean. Option for a variety of industrial uses. [5]

5.3 Equipments for process reaction batch reactor

Simplest kind of vessel used in industries is called as batch reactor, usually fitted with an agitator and internal heating/cooling mechanisms. Batch reactors come in volumes ranging from one liter to fifteen thousand liters. Batch reactors are used in many different sectors, such as the manufacturing of unusual alloys, glass, stainless steel, and steel. Through connectors in the top cover, the liquids or solids needed for the operation are added to the batch reactor. Similar connections are used to release any created gases or vapours. Following the conclusion of the chemical processes, remaining liquids can be drained from the reactor using discharge ports located at its bottom. Useful in working with strong and dangerous substance. [1]

Batch reactors usually employ a centrally located driveshaft with an overhead driving unit and impeller blades mounted on the shaft. There might be differences in the designs of the blades, which account for almost two thirds of the reactor's diameter. In addition, baffle stationary blades are often used to block the flow that is created as the agitator rotates. These baffles can be attached to the vessel's lid or placed on its interior side walls. [1]

.

Advantages of batch reactors include:

- Uniformity in concentration throughout the reactor.
- Non steady state operation.
- Low cost of instrumentation and construction.

Disadvantages of batch reactors include:

- Reactions that are extremely sensitive to heat require strict temperature control.
- Every batch's quality might be different.
- They use a lot of resources.

5.4 Types of Agitators in Batch Reactor.

5.4.1 OBJECTIVES OF AGITATION: A liquid may be stirred for a variety of reasons, depending on the processing step's goals. [1]

1. Holding onto solids. [1]
2. Combining liquids, such as water and methyl alcohol [1]
3. The gas is dispensed through the liquid as tiny bubbles. [1]
4. Dispensing a second liquid that is not soluble in the first to create a suspension or emulsion of tiny droplets [1]
5. Encouraging heat transfer from the liquid to a jacket or coil [1]

5.4.2 Agitation Equipment

In a tank with a spherical bottom and no sharp edges, liquids are often stirred. The tank's top is largely closed. The tank's dimensions may change as a result. Generally speaking, the liquid depth and tank diameter are equal. The tank has no sharp bottom corners to keep liquid current from leaking through the sides. To adjust the speed, an impeller is mounted on an overhung shaft that is linked to the engine and, often, a gearbox. Typically, accessories such as thermometer wells, input and output lines, jackets, coils, and other temperature measuring tools are provided. , a gearbox to change the speed. Accessories including jackets, coils, input and outlet lines, thermometer wells, and other temperature measurement devices are typically supplied. [1]

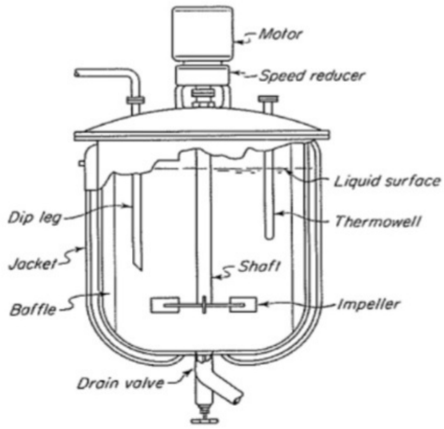

Figure - 6: Source: Unit Operations of Chemical Engineering Mc Cabe & Smith

Agitation Process Vessel

Agitators are capable of handling a wide range of media, including solids (such granules and powders), gases, and liquids. They can deal with very viscous liquids, slurries, and suspensions. Viscosity and sensitivity to shear stress are two important considerations when choosing the kind, size, and design of agitator. Agitators are widely used in a variety of sectors, including paint, water treatment, biotechnology, food & beverage, and pharmaceutical. [1]

Here are a few instances of the many kinds of agitators that are employed:
:

a) Paddle Agitator - It has two flat impeller blades that resemble paddles and extend to the tank walls. When significant axial and radial flow is not needed, it is employed. These impellers are used for heat transmission, crystallization, dissolution, and low viscosity liquid mixing. Additionally, they could offer a laminar low shear flow. When run at reduced speeds, it mostly creates a tangential flow pattern. Additional blades can be added to paddle blades to enhance the mixing of thick materials. [1]

b) Anchor Agitator - Their impellers are designed to resemble anchors. They usually have a U-form that corresponds with the tank's shape. They provide a tangential flow pattern that is dominating. [1]

c) Propeller Agitator - Propeller an axial-flow impeller running at high speed. Various sized propellers revolve at various motor speeds: larger propellers rotate at 400–800 r/min, whereas smaller propellers rotate at 1150 r/min. The liquid flow currents follow a predetermined path after leaving the impeller until being diverted by the vessel's floor or wall. The very erratic, spinning liquid column that emanates from the impeller entrains the static liquid during flow, very likely to a far greater extent than a comparable column from a stationary nozzle. [1]

D) Pitched- Agitator Blade The blades of pitched blade turbine agitators are angled and flat. The most popular kind of agitator is a turbine with four blades that is angled 45 degrees from the incline. It provides both axial and radial flow, with former being more prevalent than the latter. It has an excellent mixing efficiency and produces a lot of shear. It is applied to gas dispersions and solid suspensions. [1]

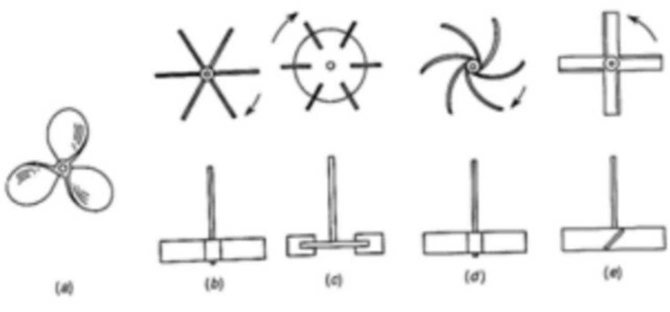

Figure – 7: Source: Unit Operations of Chemical Engineering Mc Cabe & Smith

Mixing Impellers: (a) three blade marine propeller: (b) open straight-blade turbine

(c) Bladed disk turbine: (d) vertical curved-blade turbine: (e) pitched blade turbine

5.5 Types of Jackets:

a) PLANE JACKET-

It's like an extra layer of protection that covers the whole vessel or just a part of it. A heating or cooling media is circulated through the circumferential region, which is area between vessel wall and jacket wall. Simple jackets work well for small vessels and activities when the vessel's internal pressure is greater than twice that of the jacket. The jacket might be designed with spiral baffles to improve heat transmission. By creating turbulence, these baffles raise the coefficient of heat transmission. As such, a vessel including spiral baffles and a simple jacket can be employed. [1]

b) LIMPET COIL JACKET -

The pipe is bifurcated into two parts, and the vessel wall is welded to a half-pipe coil. This arrangement encourages turbulence and high velocity in the system. Moreover, it reduces costs by strengthening the vessel wall. The inclusion of a half coil jacket provides structural stability, which is advantageous for tasks involving high temperatures. Although carbon steel is the most common material used to make lippet coil jackets, other alloys such as stainless steel and inconel can also be used. A limpet coil jacket is recommended if the jacket pressure is the determining element in the vessel wall thickness. These jackets are used in high-capacity containers in scenarios where high circulation velocities are necessary for materials like heated oils and glycols. [1]

5.6 Utilities

- Steam
- Power
- CH water
- CH brine
- CT water
- Warm Oil

Used according to the process requisites. [6]

Here are a few reactors that are used in the production of VEN along with information on their capacity, MOC, and agitator type. Furthermore stated in this report are a few filtering equipment together with their MOC and capacity.

Name	Capacity	MOC	Agitator
R1	3KL	SS-316	Anchor
R2	6.3KL	MS-GL	Propeller
R3	2KL	SS 316	Anchor PBT
R4	5KL	MS-GL	Propeller
R5	5KL	MS-GL	Propeller

Table – 1: Process Reactors: Source: TEVA API India Ltd.

Name	MOC	CAPACITY
NF	750 L	SS-HL
ANF	2.5 M	SS-HL
SF	Data not available	SS-316

Table – 2: Process Filters: Source: TEVA API India Ltd.

5.7: Process Flow Diagram of VEN Formation

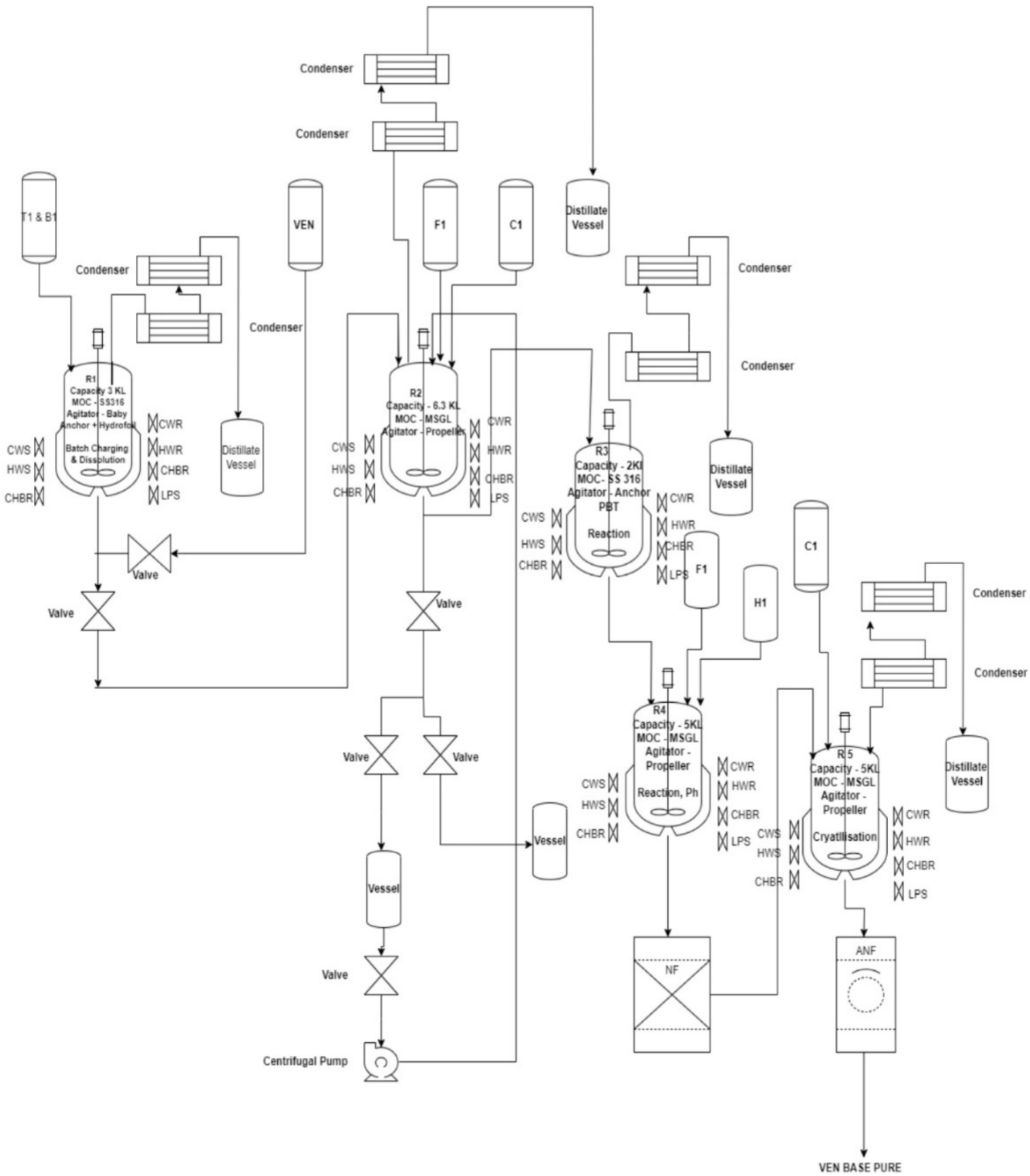

Figure – 8: Source: Diagram.io

PFD of VEN of Formation

5.8 Block Flow Diagram of VEN Formation

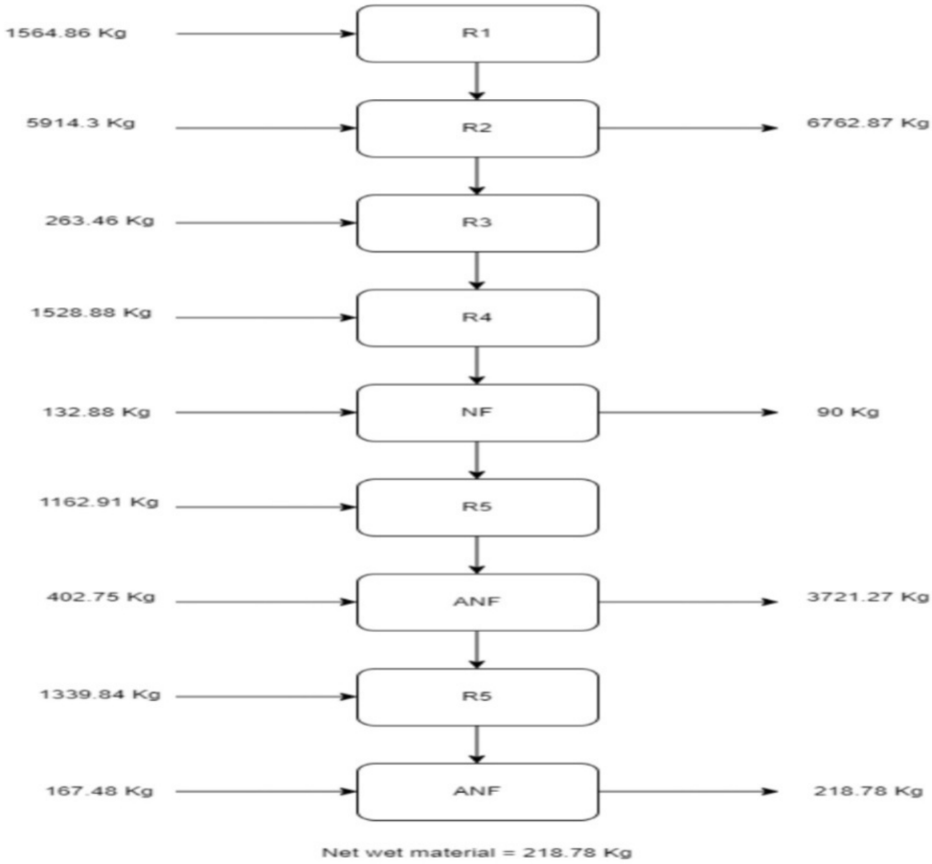

FIGURE – 9: SOURCE: DIAGRAM.IO

BFD OF VEN FORMATION

5.9 Process Description

1. Solution preparation is the first step of the process.
2. The KRM is mixed with T1 in reactor RO. Temperature range 25-35 C for dissolution.
3. The formed Solution is then transfer into R1 with other raw materials.
4. In R1 reaction is done.
5. Moisture sampling is done, moisture limit not more than 0.3% in R1.
6. In R2, reacted material from R1 fed by AOD pump.

In R2 4.5 w/v T1 is recovered

- Layer Separation
- LP 1 Product Layer : Organic Layer
- LP 2 Product Layer : Aqueous Layer
- LP 3 Product Layer : Aqueous Layer
- LP 4 Product Layer : Organic Layer
- LP 5 Product Layer : Organic Layer

End Layer remain in R2 other layer discarded to SRP.

7. Material introduced for reaction into R3.
8. For Reaction and Ph. 3, from R3 to R4; after which, the material is supplied to NF.
9. Feed the filtrate to R5 to cause crystallization and pH.
10. After that, it went via ANF. ML rejected
11. Product of wet crude stuff on LOD basis.
12. VEN Crude is injected into R once more in order to crystallize.
13. Moved through ANF once again, ML being rejected.
14. Total Weight VEN produced was 218.78 kg.

CHAPTER 6: RESULTS AND DISCUSSION

Key Raw Material	225 Kg
VEN Product Formed	218.78 Kg

Calculated Yield: 0.97

*Yield Range: 0.88-0.98

Loss: 6.22 Kg

*Yield is taking from TEVA API India Ltd. Batch Card

6.1 Possible Reason of Loss

The loss experienced 6.22 kg can be due to many reasons such as:

1. Mishandling: Material get wrongly handled during ANF and ANFD.

2. Filter Cake Loss: The filter cake removed from ANF can also take some of material with it as it transferred to Effluent treatment process it is of no use.

3. Filter media loss: Some material can stick at filter media.

4. Solubility of VEN in ML: Material is slightly soluble in ML.

6.2 Adjusted Yield

Material lost at Filter Stage: 0.01 Volume of Batch

= 2.25 Kg

Adjusted Yield: 0.978

Around 0.08 more the Calculated Yield.

CHAPTER 8: CONCLUSION

To sum up, the ideas of energy and mass balance are essential to many disciplines, such as chemistry, environmental science, and engineering. Accounting for mass coming into and going out of a system is known as mass balance, and it makes sure that what comes in equals the output. It is essential to comprehending industrial operations processes such as material flows, pollutant dispersion, and chemical reactions. Analogously, energy balance monitors the energy coming into and going out of a system, which is essential for assessing effectiveness, heat transfer, and overall system performance. These balances are fundamental instruments for process analysis and optimization, sustainability assurance, and environmental impact reduction. By carefully implementing the concepts of mass and energy balance, companies can increase overall efficiency, minimize waste production, and better utilize available resources. Furthermore, these balances offer insightful information on the behavior of systems, which helps in the creation of novel technologies and more effective procedures. The equipment utilized in the VEN production process, such as filters and dryers, is also included in this paper. Additionally, the process's overall block flow diagram and process flow diagram.

CHAPTER 8

8.1 Achieved Outcomes

I. **Comprehended** the preclinical research, investigations, regulatory authorization, and commercialization procedures that make up the regulatory framework for drug development.

II. **Interpreted t**he VEN material balance in light of chemical engineering concepts to gain a deeper understanding of API production.

III. **Applied** my internship experience at TEVA to the actual world of industry to improve my résumé and make me more marketable for jobs in the future.

IV. **Analyzed** VEN's mass balance, showcasing adept project management skills by organizing, arranging, and finishing assignments on schedule.

V. **Assessed** the significance of process safety using critical analysis and real-world application.

8.2 Societal Relevance

VEN's API DVF has significant societal relevance as an effective treatment for MDD, improving the lives of millions of people worldwide. VEN improves quality of life by helping individuals manage their symptoms of depression, which increases productivity and contributes more financially. Its use also contributes to reducing the stigma associated with mental health concerns by encouraging more people to seek support and treatment. Furthermore, by delaying the onset of depression and related illnesses, VEN helps to reduce the cost burden on healthcare systems and society at large. Consequently, a healthier and more productive society is promoted, and ongoing research and development in the field of mental health are encouraged.

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APPENDICES

APPENDIX – A: MASS BALANCE OF VEN

				ODV			
					KRM		
R 1						225	Kg
Input	Quantity	UOM					
T1	400.5	kg					
S1	79.89	kg					
T1 & B1	458.37	kg					
KRM	625	kg					
Total	1563.76						
R2							
D1	900	kg					
F1	99	kg					
T2	1174.5	kg					
C1	730.8	kg					
D1	900	kg					
Total	5368.06						
T1 Recovery		1012.5					
Layer Sepration loss		4727	kg				
Input							

Layer Sepration loss		4727	kg				
Input							
7478.06							
Distlation T2		1023.38	Kg				
Total loss			6762.88				
Total Output			715.185	kg			
Layer Sepration							
R3							
Input							
S2	129.95						
I1	133.5						
LS	715.185						
Total In	978.635						
Output	978.635						
R4							
Input							
P1	137.64	kg					
F1	380.23	kg					

I1	133.51	kg
R3 Out	978.635	kg
H2	22.5	kg
D1	529	kg
D1	146	kg
H1	180	kg
Total In	2507.52	
Total Out	2507.52	
NF		
Input		
R4 Out	2507.52	kg
H2	3.88	kg
D1	129	kg
Total In	2640.4	
Loss Cake	90	kg

Total Out	2550.4	kg
R5		
Input		
NF Out	2550.4	kg
C1	399.91	kg
D1	129	kg
D1	634	kg
Total In	3713.31	
Total Out	3713.31	
ANF		
R1001	3713.31	kg
I1	177.7	kg
D1	225	kg
IN	4116.01	
Loss	1958	
Loss	1763.09	

Loss	1958	
Loss	1763.09	
Total Loss	3721.09	
Total Out	394.915	kg
R5		
Input		
ANF 1101	394.915	kg
I1	1339.84	kg
Output	1734.76	

ANF			
Input			
R1001 Out	1734.76	kg	
I1	167.48	kg	
Total In	1902.24	kg	
Loss	1683.84	kg	
Total Output		218.395	kg

APPENDIX – B: ENERGY BALANCE OF VEN

	A	B	C	D	E	F	G	H
4								
5			T Charge	T Reactior	Cp	M	Energy	
6	T1		20	37.5	1.77	400.5	12405.49	
7	S1		20	37.5	0.176	79.89	246.0612	
8								
9	B1 + T1		5	37.5	0.95	459	14171.63	
10	KRM		5	37.5	0.5	625	10156.25	
11								
12								
13	D1		35	50	1	900	13500	
14	F1		35	50	0.53	99	787.05	
15	T2		20	50	0.41	1174.5	14446.35	
16	C1		20	50	0.28	730.8	6138.72	
17								
18								
19								
20	T2		35	50	0.41	978.75	6019.313	
21	D1		35	50	1	450	6750	
22	N1		35	50	0.48	535.5	3855.6	
23	C1		35	50	0.28	343.07	1440.894	
24								
25								
26	S2		73.5	97	1.26	129.95	3847.82	
27	I1							
28								
29								
30	P1		35	75		137.64		

Sheet1 Sheet2 Sheet3 Sheet4

	A	B	C	D	E	F	G	H
28								
29								
30	P1		35	75		137.64		
31	F1		35	75	0.53	380	8056	
32	I1		35	75	0.59	133	3138.8	
33	H2 D1		40	73.5	1	529	17721.5	
34	D1		40	73.5	1	146	4891	
35	H1				0.85	150		
36								
37								
38	D1		10	40	1	129	3870	
39	C1		10	40	0.28	3.8	31.92	
40								
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Sheet1 Sheet2 Sheet3 Sheet4

APPENDIX – C: DAILY DIARY

Day 1 19/01/2024 : Derive Ergun Equation , Fenske Equation.

Day 2 (20/01/2024) : Plant Visit Mini Plant learn about Reactors

At Home (21/01/24 – 25/01/2024) – Learnt about Reactors, their MOC, specifications, Types of Agitators.

Day 3 (27/01/24) – Mini Plant visit getting a deep overview.

At Home (28/01/24 –01/02/24) – Studied about different types of Filters such as ANFD, NF, SF, ANF.

Day 4 (09/02/24) –Solved Numerical On Area of Condenser.

Day 5 (10/02/24) – Our mentor given us Project on Material Balance of ODV.

At home (11/02/24 –15/02/24) –Prepare Block Flow Diagram

Day 6 (16/02/24) : Visit MPP 2 to learn about process.

Day 7 (17/02/24) : Collecting data from Plant.

At Home (18/02/24 – 22/02/24) : Learning about process and doing material balance.

Day 8 (23/02/24) : Worked on preparing excel sheet.

Day 9 (01/03/2024) : Solved the problem preparing VLE diagram between ethanol-water.

Day 10 (02/03/24) –Prepared the VLE diagram and it's calculations by Antonie Equation on excel.

At home (03/03/24 –07/03/24) : Study about different types of pumps used in Industries and their application.

Day 11 (09/03/24) : Industrial mentor gave the problem of preparing VLE diagram three components (ethanol, water, SO2)

From (10/03/24) : worked on the problem given by industrial mentor.

Taken Leave due to BARC exam (15/03/24 –16/03/24)

Day 12 (22/03/24) : Industrial mentor explained how to find VLE among three components.

Day 13 (23/03/24) : Leave

At home (24/03/24 – 28/03/24) : Studied different types of jacket used in Reactors.

Day 14 & 15 (29/03/24 –30/03/24) : Visit The ETP plant.

At home (01/04/24 -04/04/24) : Studied different types of crystallization methods.

Day 16 & 17 (05/04/24 –06/04/24) : Visit Solvent Recovery Plant.

At home (07/04/24 – 11/04/24) : working on excel sheet

Day 18 & 19 (12/04/24 – 13/04/24) : collecting data and doing on spot corrected material balance. Also collected Temperature.

At home (14/04/24 – 18/04/24) : Performing mass balance on excel sheet.

Day 20 (19/04/24) : Visit MPP2 to learn about process.

Day 21 (20/04/24) :Industrial mentor given us topic about time taken in distillation of R2 .

At home (21/04/24 – 25/04/24) : Worked on the problem given by Industrial mentor.

Day 22 (26/04/24) : Submitted the task related to the calculation of distillation time.

Day 23 (27/04/24) : Performing mass balance and encountering the losses and recovery.

At home (28/04/24 -02/05/24) : Performing energy balance at home in excel sheet also correcting the mass balance. Also started prepairing report to submit at the TEVA.

Day 24 & 25 (03/05/24 – 04/05/24) : Presented soft copy of report to industry mentor, they gave me some corrections to be done in the report.

At home (05/05/24 – 09/05/24) : Corected the report and add some new things.

Day 26 & 27 (10/05/4 – 11/05/24) : Preneted our repot to industry mentor, and the report was correct, Industry mentor approved my report.

At home (12/05/24 – 16/05/24) : Meanwhile prepairing for Professional Fevlopment Evaluation, collecting the certificates and arranging them in order. Also start making Final Submission Internship report that to be submitted in Institute.

Day 28 (18/05/24) : Submitted the report at TEVA and collected the internship certificate from HR Department.