ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

DESIGN AND PARAMETRIC MODELING OF ACCUMULATOR USING ANSYS

Ramu Garugubilli
Assistant Professor, Department Of Mechanical Engineering Avanthi Institute Of Engineering And Technology Bhogapuram (M), Vizianagaram (Dist).

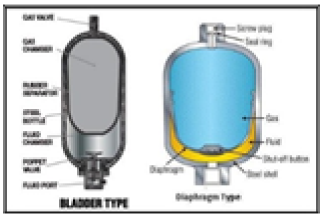
Marupalli Venkatesh
M.Tech Student, Department Of Mechanical Engineering Avanthi Institute Of Engineering And Technology Bhogapuram (M), Vizianagaram (Dist).

Abstract

A description is presented on how to perform fundamental analyses for accumulators used to maintain pressure control in closed-loop fluid systems. Since the accumulator is one of the most important component with the largest sound radiation surface area in rotary compressor, its noise contribution may be substantial. Noise generation and transfer mechanism of the accumulator are so complicated that it is difficult to identify the acoustic characteristics, because both structural and cavity modal are possible to be excited by many sources such as structural vibration, aero-acoustics, pressure pulsation etc., in addition coupling between them cannot be ignored either. In this paper, both of the noise generation and transfer mechanism are studied systematically, also standing wave and me mechanical vibration theory are applied to build the mathematical model.

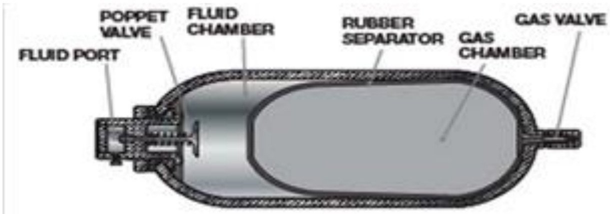
CHAPTER - 1 INTRODUCTION

Accumulator



1. General Overview:

Hydraulic fluid itself has a very high bulk modulus, miniscule changes in the volume of a closed hydraulic system result in large swings in pressure. Pump-motor noise can cause unsafe pressure fluctuations in this way if unaccounted.



Schematic Diagram Of Hydraulic Accumulator

Where is a capacitive factor, capacitance in the case of capacitors, compliance in the case of springs, and compressibility in the case of pressure vessels (Karnopp 52)? Furthermore, when written in this form, the capacitive factors of multiple elements can be easily combined analytically. When N elements meet at a junction of common effort. This can most easily observed in the case of capacitors arranged in a parallel circuit. Each capacitor stores the same amount of charge as it would if the other parallel branches were removed, because each capacitor sees the same effort (voltage) as the next. Therefore, the total capacitance of the circuit is equal to the sum of capacitance.

Cite this article as: Ramu Garugubilli & Marupalli Venkatesh, "Design And Parametric Modeling Of Accumulator Using Ansys", International Journal & Magazine of Engineering, Technology, Management and Research (IJMETMR), ISSN 2348-4845, Volume 9 Issue 12, December 2022, Page 1-8.

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2. History of hydraulic accumulators

• A hydraulic accumulator enables a hydraulic system to:

• cope with extremes of demand using a less powerful pump

• store power for intermittent duty cycles

• provide emergency or standby power

• respond more quickly to a temporary demand

• smooth out pulsations

• Compensate for leakage loss.

• A hydraulic accumulator is essentially a type of energy storage device.

3. Types of Hydraulic Accumulators

- Piston Type Accumulator
- Bladder Type Accumulator
- Diaphragm Type Accumulator
- Spring Type Accumulator

CHAPTER-2: Literature Survey

Zainol (1990) have reported that the major problem of back pressure vessel was the loss of steam of about 27 to 50% to the atmosphere. This is due to its design and size which are not specific for accumulating and controlling the steam distribution to the sterilizers and factory heating.

Mustafa (1994) have identified three major types of disturbances that led to the severe steam fluctuations in steam supply and demand.

Sivasothy (1997 & 1998) have identified that one of the problems experienced with boiler control systems was the slow dynamic response of the steam pressure to changes in fuel firing rate.

A practical and integrated approach to the steam management for palm oil mills known as the mill wide intelligent steam management control system was proposed by Lim et al., (1997).

The first steam accumulator was installed at the beginning of this for balancing the waste steam from winding machines (Goldstern, 1970).

Ruths (1913) then applied the same basic principle of steam storage to higher pressure systems and automatic operations in 1920's.

This was followed by similar developments of the feed water storage system or constant pressure accumulator for medium fluctuations, especially the displacement type in 1960 (Godall, 1980). For power station applications, special storage systems for turbines were developed with pressures up to 150 bars in 1938 (Lyle, 1947).

The basic tests of Eberle (1929) have shown that primarily the steam space and not the evaporative surface is important for the maximum permissible evaporation (Goldstern, 1970). In other words no two steam accumulators are comparable, since besides differing in dimensions and method of storage, the range of pressure or temperature and the arrangement within the steam plant may be different, as well as the type of operation and the purpose of the steam accumulator (Goldstern, 1970).

Mohd. Halim Shah; A.A. Mustafa Kamal; M. Noor Azian Previous work in the area of improving the performance of steam system in palm oil mills can be found in books and journals published by Malaysian Palm Oil Board (MPOB). However, very little data has been published on operating experiences and scientific facts as well as economic aspects of back pressure vessel system. The data is also often found to be contradictory with the actual industrial requirement in handling pressure fluctuation of steam line in palm oil mill. Furthermore, there is very scarce literature on proper sizing methods for back pressure vessel. The design of back pressure vessel in palm oil mills is still largely based on undeveloped approaches and is carried out by individuals lacking exposure to the palm oil milling industry.

Mohd. Halim Shah; A.A. Mustafa Kamal; M. Noor Azian

(Profiled Authors: Mustafa Kamal Abdul Aziz; Noor Azian Morad) European Journal of Scientific Research. 2009;37(4):628-640.

A field investigation was done in a typical palm oil mill, the Tanah Merah Palm Oil Mill, Malaysia. There had been previous report of pressure fluctuations and losses of steam especially at boilers and back pressure vessel when sterilisers were operating at normal steam load condition. Field trips were undertaken for this investigation. The field works study was aimed towards studying fluctuation in the overall steam supply and demands in the mill. This study on variations in energy availability and steam distribution to various parts in the mill was initiated to provide a bottom-line understanding of the mill current operating situation and identify steam losses and fluctuation problems. The total steam consumption and losses in the mill could be then determined. Total fuel (press fiber and shell) produced for each tonne of FFB processed, fuel consumption by the boiler operation and performance of the sterilization process were also considered during field investigations. The relevant data at various sites collected on the field trips were used to verify mass and energy balances on the steam system, identify critical problems in steam demand fluctuation and develop mathematical model for representing the process operation at referred areas in the palm oil mill. The study also attempted to review the possibility to install a steam accumulator in the mill to stabilize the steam pressure fluctuations especially at the demand sides.

Mohd Sharizan Md Sarip; Noor Azian Mora

(Profiled Author: Noor Azian Morad) Advanced Materials Research. 2012; 550-553:1900-1903.

Triet H.H. Et.al [1] in the present paper, a novel hydraulic energy recovery system was presented with modelling, simulation, and experimentation on the test rig.

Lin C.C. et.al [2] proposed the Power Management Strategy for a Parallel Hybrid Electric Truck. Designing the power management strategy for HEV(Heavy Earth Vehicles) by extracting rules from the Dynamic Programming(DP) results has the clear advantage of being near-optimal, accommodating multiple objectives, and systematic. Hybrid vehicle techniques have been widely studied recently

Douglas C. et.al [4] have developed a mechanical kinetic energy recovery system (KERS) utilizing a high speed carbon filament

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flywheel and a Torotrak full-toroidal traction drive Continuously Variable Transmission for use both within F1 and motorsport but also for mainstream automotive Applications This paper describes the Formula 1 system and the development of road car systems covering the energy storage requirements, system efficiencies, energy savings and hence fuel economy and performance improvements.

World pump [5] it is A European steel manufacturer .it done a test on hydraulic system to see the amount of energy saving, tests were carried out to establish if a drive would be a viable option for controlling energy consumption with PID (Proportional, integral and differential controller) .after the test it is found that 70% energy saving was successfully reached..

Guzzella, L. et.al [6] proposed A. Vehicle propulsion systems with its modeling and optimization. In this paper the longitudinal behavior of road vehicles is analyzed.

Shen, S. et.al [7] have been developed the Analysis and control of a flywheel hybrid vehicular powertrain.

Bin WU et.al [8] have been proposed the Optimal Power Management for a Hydraulic Hybrid Delivery Truck. Hydraulic hybrid propulsion and energy storage components demonstrate characteristics that are very different from their electric counterparts, thus requiring unique control strategies.

Triet H.H. Et.al [9] have been developed A novel energy-saving hydraulic system based on an HST/hydraulic accumulator combination was investigated through analysis and modeling.

Pourmovahed [8] discusses that frequent compression and expansion of the foam may cause plastic deformation.

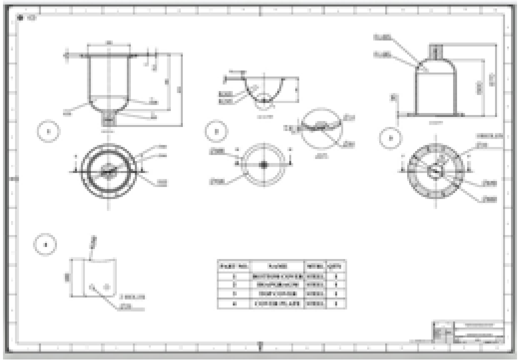
Pedchenko and Barth [11] suggest using a polyurethane bladder to store energy through strain rather than compressing and expanding a gas.

The last method for improving accumulator energy storage is given by a patent filled by Gray and Hellman [12], referred to as the “Accumulator Engine”

3.2 Different parts of diaphragm accumulator

- Bottom cover
- Top cover
- Diaphragm
- Diaphragm plug
- Gas inlet valve
- Pressure valve (i)
- Pressure valve (ii)
- Hydraulic inlet valve
- Gas outlet valve
- Relief valve
- Nut & bolt
- Assembly of bottom cover & diaphragm
- Total assembly
- Different views of diaphragm accumulaton

- Inputs For The Project
- 2D Drawing

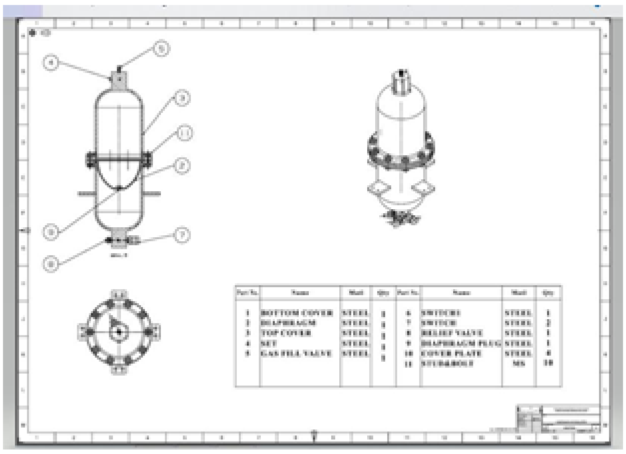


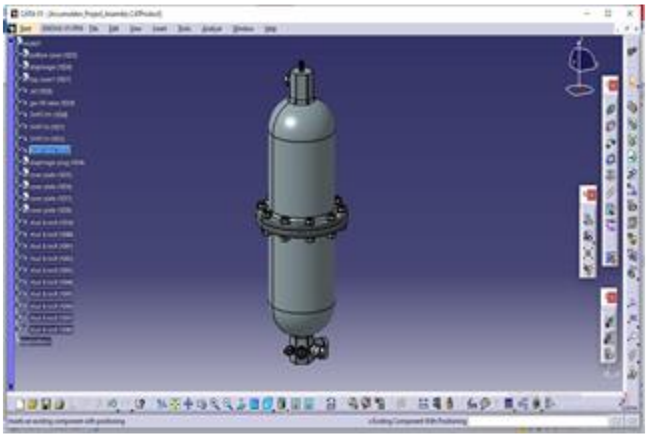
A 2D drawing is used to design a 3D model for our component using Catia software. Below shows the 2D drawings of the diaphragm accumulator with all the required dimensions and GD&T representations the suits the best for manufacturing the component without any errors.

2D Drawing:

- Bottom Cover
- Diaphragm
- Top Cover
- Cover Plate

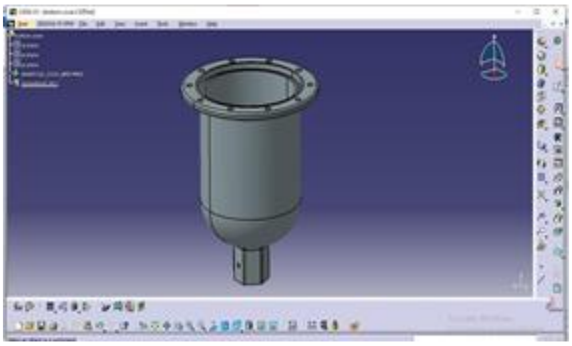
Figure 8: Assembly Drawing





Top Cover

Assembly of bottom Cover & diaphragm



Total assembly

CHAPTER: 4 Ansys Introduction

Dr. John Swanson founded ANSYS, Inc. in 1970 with vision to commercialize the concept of computer-simulated engineering, establishing himself as one of the pioneers of finite element analysis (FEA). ANSYS Inc.

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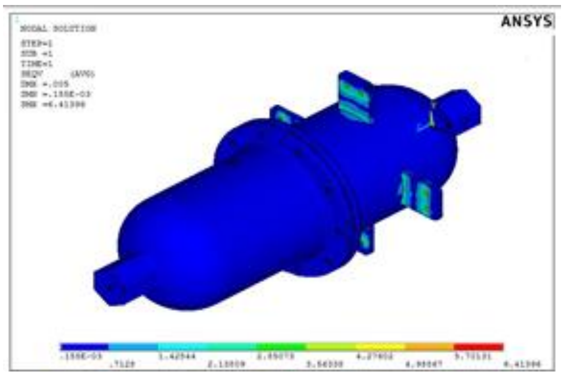
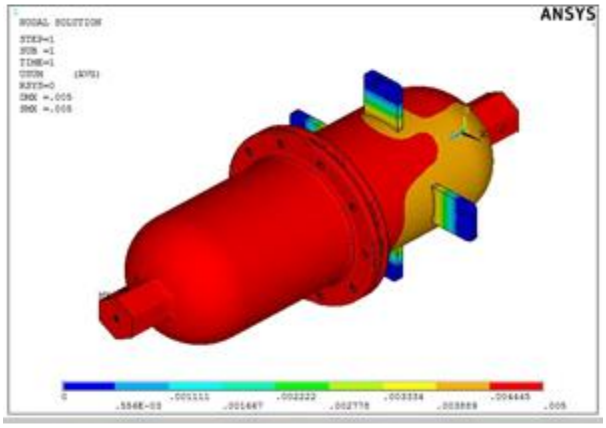
supports the ongoing development of innovative technology and delivers flexible, enterprise-wide engineering systems that enable companies to solve the full range of analysis problem, maximizing their existing investments in software and hardware.
ANSYS has evolved into multipurpose design analysis software program, recognized around the world for its many capabilities. Today, the program is extremely powerful and easy to use. Each release hosts new and enhanced capabilities that make the program more flexible, more usable, and faster. In this way, ANSYS helps engineers met the pressures and demands of the modern product development environment.

The ANSYS program is a flexible, robust design analysis and optimization package. The software operates on major computers and operating systems, from PCs to workstations to supercomputers. ANSYS features file computability throughout the family of products and across all platforms. ANSYS design data access enables user to import computer-aided design models into ANSYS, eliminating repeat work. This ensures enterprise-wide, flexible engineering solution for all ANSYS user.

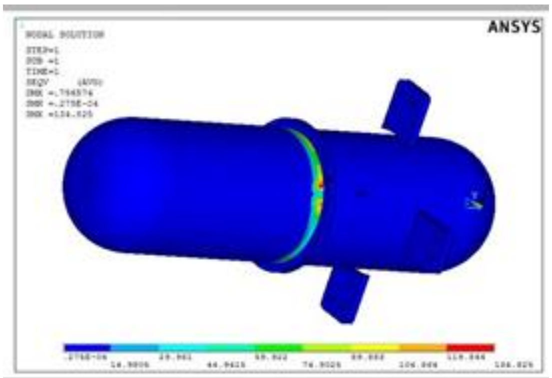
Chaper-5 Accumulator Analysis
STRUCTURAL STATIC ANALYSIS
8.Gravitational Analysis



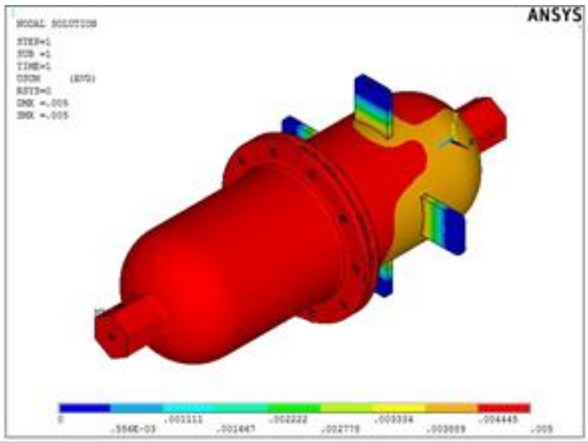
Stress Plot
Displacement Plot



9. Pressure analysis



Internal stress plot
Applied Pressure Load
10. MODEL ANALYSIS
The first natural frequency is 85 hz so the structure is robust for avoiding any kind of vibrations



Their information.

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How to Use the Sizing Chart

These charts are used to find accumulator size Vo when the required output ΔV is known.

Step 1

As the accumulator output ΔV is known, choose the appropriate pair of charts from the two sets shown opposite. For outputs up to 50 liters use charts A and B, and for outputs above 50 liters use charts C and D. In this case, as the required output is 6 liters, charts A and B should be used.

Pre-charge	90% of 100 bar = 90 bar
Adiabatic / Isothermal	Adiabatic
Accumulator selected	A6ES2310L2K

Step 2

Calculate P2/P1 by dividing the maximum system pressure by the minimum pressure required to make the machine function. In this case, 170/100 = 1.7

Step 3

Using chart A, locate 1.7 on the X-axis and draw a vertical line to the top of the chart.

Step4

Depending on the cycle time, select the appropriate curve on chart A. For fast cycle times, use the adiabatic curve; for slow cycle times, the isothermal curve should be used. In this case, use the adiabatic curve. (n and f = 1.8)

Step 5

On chart A, identify the point at which the vertical line drawn in step 3 crosses the chosen curve (in this case adiabatic) and draw a horizontal line across to the right hand end of chart B.

Step 6

Using the lower X-axis on chart B, locate the required accumulator output (ΔV), in this case 6 liters.

Draw a vertical line to the top of the chart.

Step 7

Locate the point where the vertical line drawn in step 6 crosses the horizontal line drawn in step5. Locate the first curve to the right of this intersection.

Step 8

Follow the curve selected in step 7 up to the top X-axis (Vo) and read off the required accumulator size, in this case 30 liters. Always round up to the next largest size available; for this example, therefore, a 38 liters accumulator should be selected.

Summary

Pre-charge 90% of 100 bar

= 90 bar

Adiabatic /

Isothermal Adiabatic

Accumulator

selected

A6ES2310L2K

CHAPTER-6: Conclusions

- Based on the Analysis results, the designed Bladded type Accumulator is safe for the applied internal pressure.
- The initial natural frequency is 85 Hz, which indicates the robust structure for avoiding vibrations.
- The design has the following advantages for working prototype.
- Lower installed system costs, accumulator assisted hydraulics can reduce the size of the pump and electric motor which results in a smaller amount of oil used, a smaller reservoir and reduced equipment costs.
- Less leakages and maintenance costs, the ability to reduce system shocks will prolong component life, reduce leakage from pipe joints and minimize hydraulic system maintenance costs.
- Improved performance, low inertia bladder
- Accumulators can provide instantaneous response time to meet peak flow requirements. They can also help to achieve constant pressure in system using variable displacement pumps for improved productivity and quality.
- Reduced noise levels, reduced pump and motor size couple with system shock absorption overall machine sound levels and result in higher operator productivity.

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