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OBSERVATION OF WATER FLOW IN THE BALL VALVE BEFORE AND AFTER REPAIRS USING LAPPING MACHINES

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Abstract
In industrial piping systems, particularly in the oil and gas, petrochemical, and power generation sectors, ball valves are one of the most important components in controlling fluid flow. Defects on the contact surfaces pose risks of leakage, pressure drop, and flow disruption. These issues not only reduce system efficiency but also increase the potential for further damage. One of the commonly used repair methods is lapping, which is the process of smoothing the surfaces of the ball and seat to improve contact compatibility. The effectiveness of lapping is typically tested through a hydro test, where pressure stability over time serves as the primary indicator of post-repair flow performance. The primary objective of this study is to identify changes in pressure patterns and analyze trends in pressure stability in ball valves before and after repair using a lapping machine, evaluated through a hydro test. The research method is a quantitative experiment. Data collection is based on pressure-versus-time graphs from the hydro test on each ball valve in two conditions: before and after lapping. The results of the study show that before lapping, all ball valves experienced significant pressure fluctuations and were unable to maintain test pressure, indicating leakage. However, after the lapping process, the ball valves consistently showed a drastic improvement in performance, with stable pressure graphs and the ability to maintain maximum pressure (±900 - 920 psi) during the holding phase. These findings significantly contribute to the understanding that lapping is a highly effective repair method for restoring the sealing integrity of ball valves. The lapping process successfully restores the ball valve's ability to withstand pressure optimally, thereby improving water flow stability. Implicitly, this method can serve as an efficient practical solution for ball valve maintenance in industry.
Keywords: Ball Valve, Lapping, Hydro Test, Pressure Stability.

Introduction

In industrial piping systems, especially in high-pressure sectors such as oil and gas and energy, ball valves are essential components for flow control[1]. The performance of these valves is highly dependent on the quality of the sealing between the ball and the seat[2]. However, micro-damage or surface wear over time often leads to a decrease in seal quality, leading to leakage and pressure drop when hydrostatic tests are performed[3]. This problem not only reduces operational efficiency but also increases the risk of system failure. Standard repair methods, such as lapping, aim to smooth the contact surface and

[1] Schmitz, F. J. F. K., & Persson, A. T. B. N. J. (2020). Fluid Leakage in Metallic Seals. *Tribology Letters*, *68*(4), 1–11. https://doi.org/10.1007/s11249-020-01358-x
[2] Peng, D., Dong, S., Wang, Z., Wang, D., Chen, Y., & Zhang, L. (2021). Characterization of the solid particle erosion of the sealing surface materials of a ball valve. *Metals*, *11*(2), 1–19. https://doi.org/10.3390/met11020263
[3] Rahmi, M., & Canra, D. (2018). *Analysis of Fluid Pressure Differences in Full Closed and Full Open Condition Ball Valves with Abstract Computational Fluid Dynamics*. *Sec. 4*, 7–11.

restore tightness[4]. Although lapping has proven to be effective, evaluation of its success is still often less objective. Therefore, a more quantitative approach is needed, i.e., the analysis of pressure graphs over time from the hydrotest results to accurately and objectively assess the stability of post-repair flows.

Based on the need for a more objective evaluation, this study formulated a problem to identify patterns of change and pressure stability trends over time in 16-inch ball valves with three material variations (F51, F316, and A105ENP), both before and after the lapping process. The scope of this study is strictly limited, focusing only on the comparison of pressure graphs of hydrotest results and does not include measurements of flow variables (such as discharge or coefficient of variation - Cv), nor metallurgical testing (such as microstructure or hardness). With these limitations, the main objective is to identify pressure patterns and analyze the stability of post-lapping water flow, providing a valid and applicable evaluation tool for industrial maintenance.

Literature Review

Components and Working Principle *of Ball Valve*

A valve is defined as a mechanical device that functions to regulate fluid flow or pressure, including open/close functions, speed control, flow diversion, and backflow prevention. *A ball valve* is a type of valve that uses a ball-shaped disc to control the flow of fluid. This valve operates using a *quarter-turn* mechanism.

The main components *of the ball valve* include *the Body*, *Ball* (a perforated ball that can rotate 90^{o}, *the Stem* (a connecting rod to the actuator), and *the Seat* (a component that serves as a fluid inlet/outlet as well as a contact *sealing element*). The effectiveness of *sealing* is greatly influenced by the geometry, the *ball material*, and especially the level of surface smoothness. Irregularities in the contact area between *the ball* and *the seat* can trigger water leakage[5].

The *ball valve* materials tested in this study are F51 (*Duplex Stainless Steel*), F316 (*Austenitic Stainless Steel*), and A105ENP (*Carbon Steel*) are commonly used in high-pressure systems. F51 and F316 are known for their high corrosion resistance.

Basic Principles of Dynamic Fluids

The study of water flow in *a ball valve* involves the basic principles of fluid mechanics. A fluid is defined as a substance that has the ability to flow, including liquids and gases. The water used as the test medium in *the hydro test* is categorized as an incompressible fluid[6].

The continuity equation is based on the principle of mass conservation, which states that the rate of mass flow entering a control volume must be equal to the rate of mass flow out. Mathematically, flow discharge (Q) can be formulated as:

[4]Rahmi, M., Canra, D., & Suliono, S. (2018). Analysis of the strength of the ball valve due to fluid pressure using finite element analysis. *JTT (Journal of Applied Technology)*, 4(2), 79–84. https://doi.org/10.31884/jtt.v4i2.122
[5] Molenda, J., & Barylski, A. (2015). Al2O3 SEALING ELEMENTS LAPPING. *Journal of KONES. Powertrain and Transport*, *19*(3), 311–318. https://doi.org/10.5604/12314005.1138140
[6] Zami, Z. (2010). Analysis of valves and their damage. *Voice of Engineering: Scientific Journal*, *1*(2), 70–76.

$$\frac{\partial \rho}{\partial t} + \nabla.(\rho v) = 0$$

Where:

ρ = density of fluid

v = fluid velocity

t = time

$\nabla.(\rho v)$ = divergence of the fluid velocity vector multiplied by density

Bernoulli's law is based on the principle of conservation of energy for an incompressible ideal fluid flow.

$$P + \frac{1}{2}\rho v^2 + \rho g h = konstan$$

Where:

P = water pressure(Pa)

v = water velocity (m/s)

g = acceleration of gravity

h = water level (m)

ρ = Fluid density (kg/m3)

In the context of *a hydro test* (where the *ball valve* is fully closed and it is assumed *that v* is close to zero, as well as h constant), *sealing* failure will cause a decrease *in pressure P* observed on the *pressure gauge*. Pressure stability is a condition for achieving energy conservation conditions in an ideal closed system.

Mechanism and Function of Lapping Machine

Lapping is an abrasive leveling process that aims to remove excess material from high points on the surface of a component[7]. This process results in a very smooth surface finish, often with *a matte look*, as well as achieving tight geometric tolerances.

The *lapping* process utilizes fine abrasive particles, such as silicon carbide or aluminum oxide, which are mixed with liquid (slurry) and placed between the workpiece (*ball* and *seat*) and *the lapping plate*. The relative movement between the components and the *lapping* plate causes micro-abrasion, effectively eroding uneven surface parts, scratches, or irregularities. Important process parameters include load, rotation speed, *slurry* type, and abrasive particle size[8].

In *ball valve repair*, the purpose *of lapping* is to optimize the tight contact between the *ball surface* and *the seat*, thereby increasing the effective contact area and facilitating better sealing. Thus, leaks caused by micro-cracks or wear can be significantly reduced.

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[7] Surfacing, P. S. (n.d.). *What is Spherical Lapping*? Lapmaster. Retrieved December 28, 2024

[8] Sebastian, H., & Purwaningsih, R. (2021). Analysis of the productivity value of lapping machines with the overall equipment effectiveness approach at Pt. Fluid Science Dynamics Indonesia, Tbk. *IDEC National Seminars and Conferences*, 2579–6429.

Methodology

This study adopts a quantitative experimental approach to evaluate the influence of mechanical repair processes on the hydrodynamic characteristics of *ball valves* .

1. Independent Variables: The status *of the ball valve*, which is differentiated into pre-lapping (initial condition) and post-lapping (repair condition).
2. Dependent Variable: The stability of water flow, which is measured through a pressure (P) graph against time (t) during *the hydro test*. The more stable the pressure maintained, the more optimal the *sealing performance*.
3. Control Variables: To ensure an objective comparison, the following variables are kept constant:
   - Ball Valve *Size*: 16 inches.
   - Specimen Material Type: F51, F316, and A105ENP.
   - Test Fluid Type: Water (non-compressible test medium).
   - Test Method: *Hydro Test* .

Testing Procedures and Parameters

Testing is done in two phases: preliminary testing (before *lapping*) and final testing (after *lapping*). The standard hydro *test* procedure is used to measure pressure stability.

Specimens and Equipment

The specimen used is three units of 16-inch *ball valves* with materials F51, F316, and A105ENP. The key equipment used includes *Hydro Test* Machines, *Hydrotest* Pumps, and *Digital Pressure Gauges* for accurate data recording. Auxiliary components such as *the Blind Flange* are used to shut down the system during pressure testing.

Hydro Test *Mechanism*

The test process begins with preparing *Ball Valve*, fill the system with water, close the system tightly, and then press using the pump *Hydrotest* . Tech Anan is increased until it reaches a working pressure of around PM 900 psi. Once the peak pressure is reached, the system is left in a state of *Holding* for 10-15 minutes. Changes in pressure over time are recorded using *Pressure Gauge* digital.

Quantitative Parameters of the Test

Parameters	Unit	Information
Test Pressure	Psi	StuRat (talk) 19:00, 15
Holding Time	Minute	10-15
Fluid Media	Water	Non-Compressible Test Media

Surface Repair Mechanism

Repairs are carried out using a *Lapping* Machine. This process optimizes the *surface of the ball* and *seat* through micro-abrasion. The abrasive materials used include *Amril Abrasive* and sandpaper with sequential levels of roughness: Grit 150, Grit 400, to Grit 1000.

The *lapping* mechanism aims to remove microscopic defects, scratches, or irregularities on the surface that inhibit tight contact. The success of this process directly creates better sealing, which is then tested with the valve's ability to maintain high pressure.

Discussion

Ball Valve *Repair Process* Using Lapping Machine

The repair process is carried out using *a lapping* machine to restore the smoothness and flatness of the *ball valve surface*. The use of this method is particularly effective for industrial applications that require tight tolerances and defect-free surfaces. After the repair process is carried out, the *ball valve* is tested again using *the hydro test method* to evaluate the success of the process. The results showed a significant improvement in *sealing* performance on all types of *ball valve materials*.

Observations Before Repair

Before repairs, a hydro test is carried out to determine the initial condition of the *ball valve*'s ability to withstand water pressure before the repair process is carried out using *a lapping* machine. Each *ball valve* with a different material exhibits a varying pressure response to the test time. A graph of the test results is presented and supported by analysis in the form of a table.

Ball Valve F51

Tests on *ball* valves made of F51 (*duplex stainless steel*) show from the pattern of fluctuations and pressure instability that the *ball valve* has not been able to maintain significant pressure. The graph of *the F51 hydro test ball valve* can be seen in Figure 1.1

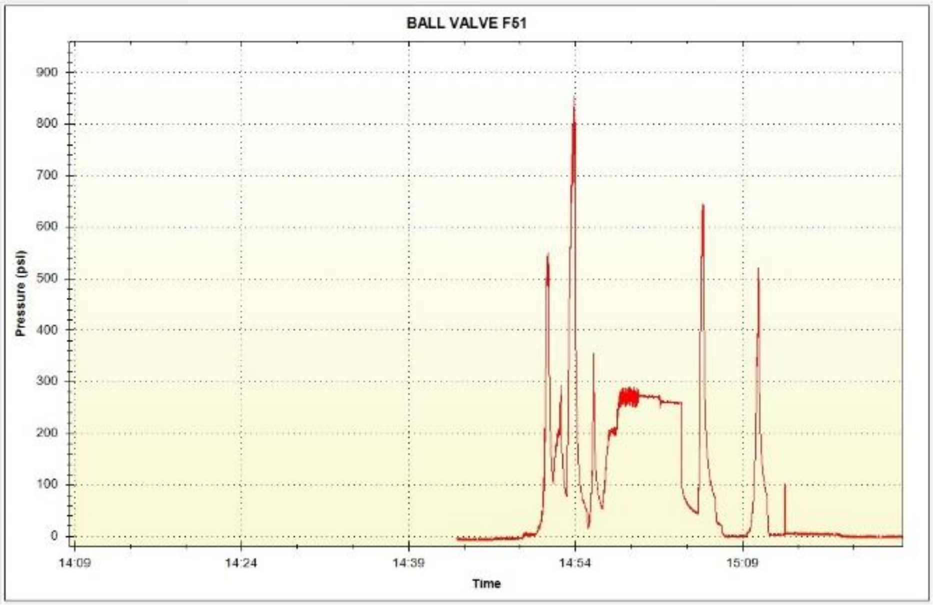


Figure 1. 1 Results Graph *Hydro Test* Before Done *Lapping* At *Ball Valve* F51

From the graph, an analysis per time interval can be compiled as shown in the following table 4.1:

Table 1. 1 Chart Analysis *Hydro Test* F51 Before *Lapping*

Yes	Time Interval	Pressure (psi)	Explanation
1	14:09 - 14:40	0	Idle phase, no pressure filling yet.
2	14:40 - 14:45	0 - ±600	The pressure begins to rise sharply, the initial injection phase.
3	14:45 - 14:54	0 - ±300	Extreme fluctuations occur, indications of leakage or unrestrained pressure. Pressure is unstable.
4	14:54-14:56	±850	A brief but untenable surge of pressure occurs
5	14:56 - 15:00	±300 - 0	There was a drastic decrease, followed by replenishment efforts, the pressure remained unstable.

Yes	Time Interval	Pressure (psi)	Explanation
6	15:00 – 15:10	±250 - 0	Several refill attempts were made but the pressure always dropped, *the ball valve* was unable to maintain the test pressure.
7	15:10 – 15:15	0	The pressure no longer appears, the test is completed and the system is emptied

Ball Valve F316'[[]c

Ball valve F316 (*Austenitic Stainless Steel*) shows the most stable initial performance compared to the other two materials. The maximum test pressure is in the range of 100 psi, and it can be maintained for a relatively long period of time. This shows the sealing is still working quite well even though it's not perfect. Graphs *Hydro Test Ball Valve* F51 can be seen in Figure 1.2.

From the graph, an analysis per time interval can be compiled as shown in table

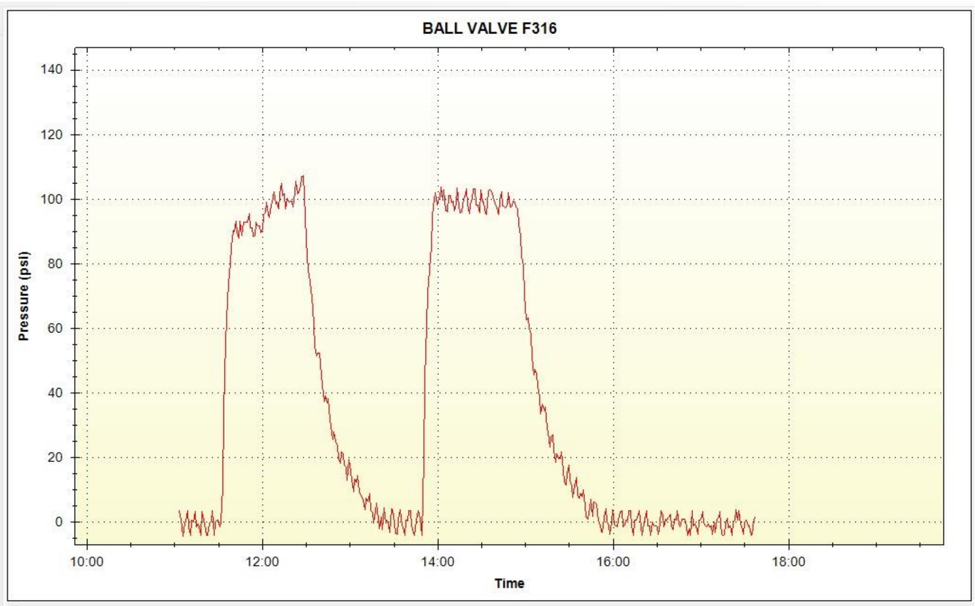


Figure 1. 2 Results Graph *Hydro Test* Before Done *Lapping* At *Ball Valve* F316

4.2 below:

Table 1. 2 Chart Analysis *Hydro Test* F316 Before On *Lapping*

Yes	Time Interval	Pressure (psi)	Explanation
1	10:00 – 11:50	0	No testing, no pressure yet
2	11:50 – 12:00	0 - ±100	The pressure increases rapidly, but only reaches ±100 psi

Yes	Time Interval	Pressure (psi)	Explanation
3	12:00 – 12:30	±100 - 0	Direct pressure drops rapidly, indicating a leak or the ball valve's inability to withstand pressure
4	12:30 – 13:50	0	No pressure
5	13:50 – 14:00	0 - ±100	A second test was performed, again only reaching ±100 psi
6	14:00 – 15:30	±100 - 0	The pattern of pressure drop repeats very quickly drastically
7	15:30 – 18:00	0	The pressure no longer appears, the test is completed and the system is emptied.

Ball Valve A105ENP

The *ball valve* material A105ENP (*carbon steel*) shows the ability to achieve the highest pressure among the three materials, which is up to ±850 psi. However, the graph shows very unstable pressure fluctuations, with repeated sharp drops, indicating indications of leakage in the *sealing*. The graph of the *results of the hydro test ball* valve can A105ENP be seen in Figure 1.3.

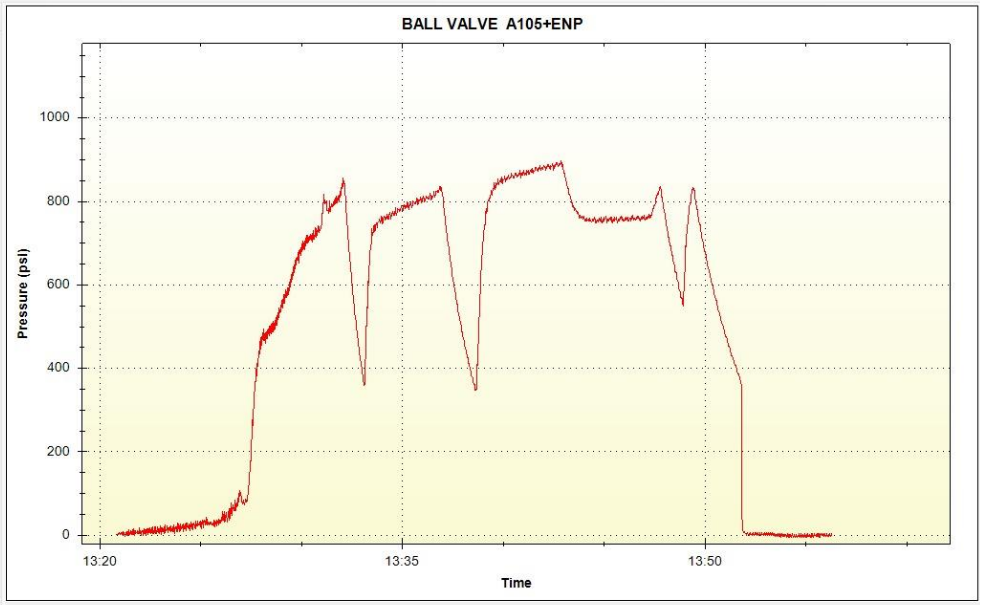


Figure 1. 3 Results Graph *Hydro Test* Before Done *Lapping* At *Ball Valve* A105ENP

From the graph, an analysis per time interval can be compiled as shown in table 4.3 below:

Table 1. 3 Chart Analysis *Hydro Test* A105ENP Before At *Lapping*

Yes	Time Interval	Pressure (psi)	Explanation
1	13:20 - 13:27	0 - ±200	Initial charging, the pressure begins to rise gradually
2	13:27 - 13:30	±200 - ±850	The pressure increases significantly, approaching the maximum value.
3	13:30 - 13:31	±850 – ±300	The first drastic drop in pressure, indicates indications of leakage.
4	13:31 - 13:34	±300 - ±850	The pressure is constantly rising.
5	13:34 - 13:35	±850 - ±350	A second pressure drop, similar to the previous event
6	13:35 - 13:38	±350 - ±850	Pressure increased again
7	13:38 - 13:40	±850 - ±700	The pressure has decreased slightly but not drastically.
8	13:40 - 13:42	±700 - ±850	The pressure is again raised.
9	13:42 - 13:45	±850 - ±400	The pressure drop is sharp, but a little slower than before.
10	13:45 - 13:50	±400 - 0	Pressure gradually drops to exhaust, testing ends
11	13:50 – 13:53	0	There is no pressure, a flat graph signals the end of a test.

Observation Results After Repair Using Lapping Machine

The ball valve repair process is carried out using *a lapping* machine, which is a method of recoating *the surface of the ball* and *seat* to improve *the quality of sealing*. After this process, *a hydro test* is carried out again to evaluate the stability of the water pressure over time, as well as ensure that there are no leaks in each type of *ball valve* material used. A graph of the test results is presented and supported by analysis in the form of a table.

Ball Valve F51

In the *F51* ball valve material, *the hydro test* graph shows that after the repair process using *a lapping machine*, the performance of the *ball valve* has significantly improved. The pressure is able to reach a maximum of ±920 psi without any drop, meaning it lasts for 15 minutes during *the holding test* period. This shows that the *lapping* process successfully restored the *sealing ability of* the F51 ball valve. The graph of the results *of the hydro test ball valve* F51 can be seen in Figure 1.4

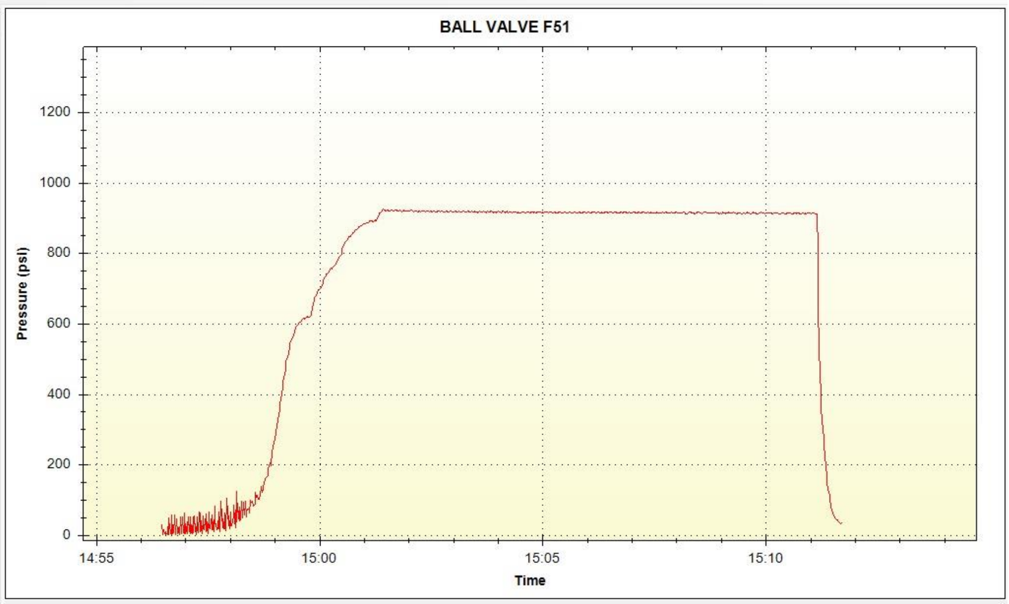


Figure 1. 4 Results Graph *Hydro Test* After Done *Lapping* At *Ball Valve* F51

From this graph, an analysis of the pressure interval to the time of the F51 material after repair can be prepared as shown in the following table 1.4:

Table 1. 4 Chart Analysis *Hydro Test* F51 After Engine Repair *Lapping*

Yes	Time Interval	Pressure (psi)	Explanation
1	14:55 – 14:58	0 - ±200	At the beginning of water injection (*pre-loading*), there is a gradual formation of pressure, accompanied by air stability in the system
2	14:58 – 15:00	±850	The pressure increases rapidly and indicates the closed system is working optimally. Cannot leak when pressure rises
3	15:00 – 15:10	±920	Holding phase. The pressure is maintained ±10min without a decrease means the pressure is stable. This signifies the sealing is working well and there are no leaks
4	15:10 – 15:12	0	Pressure drop is performed at the end of the test (*decompression*), ending the test session complete.

Ball Valve F316

On the material *Ball Valve* F316, graphics *Hydro Test* indicates that after the repair process using the machine *Lapping* shows excellent performance. In the *Holding Time*, the stable pressure reaches a maximum figure of ±900 lasting for 15 minutes, indicating that no leakage occurred during the test period. Results graph *Hydro Test Ball Valve* F316 can be seen in the Figure. 1.5

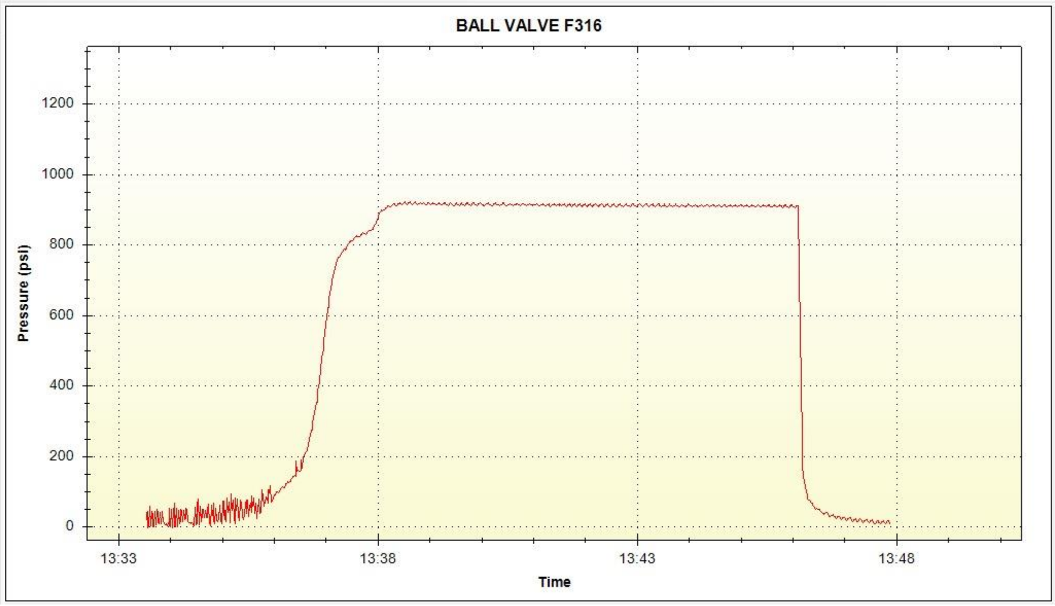


Figure 1. 5 Results Graph *Hydro Test* After Done *Lapping* At *Ball Valve* F316

From the graph, an analysis per time interval can be compiled as shown in table 1.5 below:

Table 1. 5 Chart Analysis *Hydro Test* F316 After Engine Repair *Lapping*

Yes	Time Interval	Pressure (psi)	Explanation
1	14:50 - 14:53	0 - ±250	Initial charging phase. The pressure begins to form the stability of the system with a slow increase
2	14:53 - 14:56	±850	The pressure increases ±850 psi, the system reaches optimal. No fluctuations or leaks
3	14:56 - 15:06	±900	Pressure stable, *sealing ball* and *seat* work well. Stable pressure in the *holding* phase indicates effective *lapping* repair results

4	15:06 - 15:08	0	Pressure drop, pressure process (*decompression*), end of the test session

Ball Valve A105ENP

The ball valve A105ENP which previously had an indication of pressure instability, after being fixed using *a lapping* machine, showed a stable pressure pattern. The maximum pressure is reached at ±910 psi and lasts for ±10 minutes before pressure release. The graph of the *results of the hydro test ball valve* can A105ENP be seen in Figure 1.6

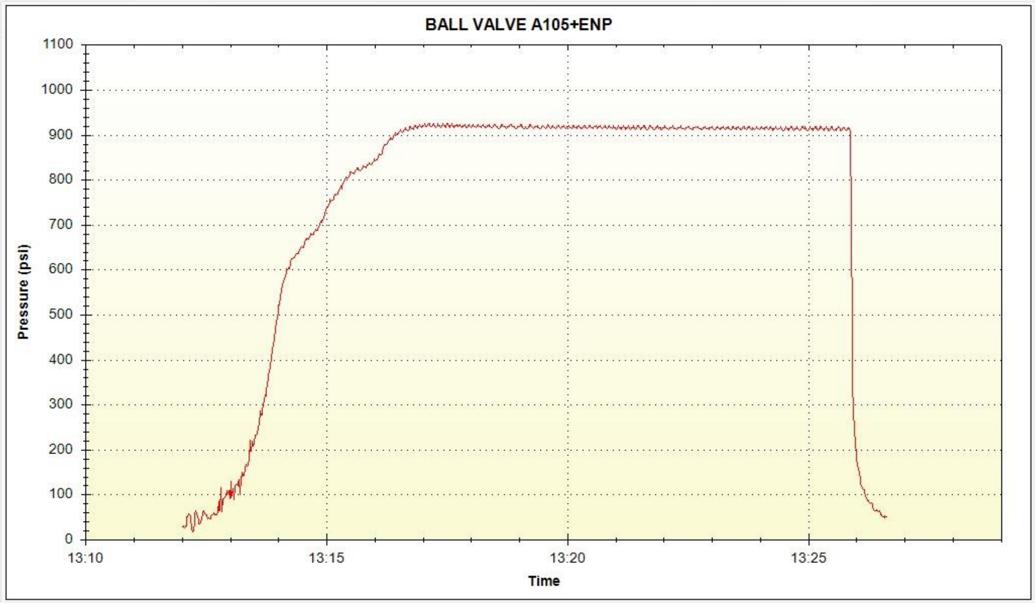


Figure 1. 6 Results Graph *Hydro Test* After Done *Lapping* At *Ball Valve* A105ENP

From the graph, an analysis per time interval can be compiled as shown in table 1.5 below:

Table 1. 6 Chart Analysis *Hydro Test* A105ENP After Repairs Using the Machine *Lapping*

Yes	Time Interval	Pressure (psi)	Explanation
1	14:45 - 14:48	±200	Initial water refill. There is a gradual formation of pressure, accompanied by air stability in the system.
2	14:48 - 14:51	±910	The pressure rises quickly and the system shows a good response. No pressure drop
3	14:51 - 15:01	±910	*Holding pressure* stable. This is proof that the *surface of the sealing ball valve* has been

Yes	Time Interval	Pressure (psi)	Explanation
			effectively repaired by *the lapping* process.
4	15:01 – 15:03	0	Pressure drops, pressure process (*decompression*), ends the testing session.

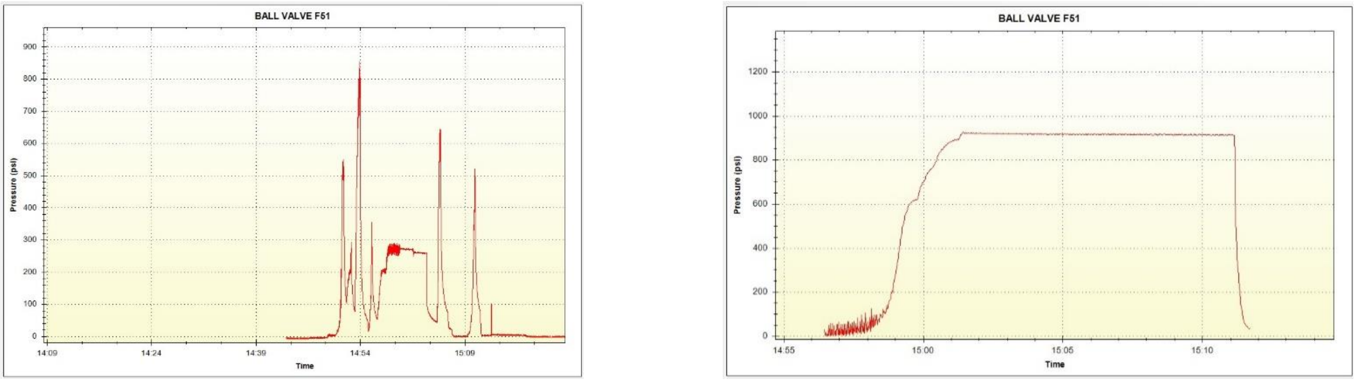
Comparative analysis of pressure characteristics (before and after)

This section presents a comparison of the pressure characteristics measured during *the hydro test* before and after repair using *a lapping machine*. This comparison aims to specifically answer the formulation of the first problem regarding the pattern of pressure changes over time.

Comparison of Pressure Patterns on Ball Valve F51

Before *the lapping* repair, *the ball valve* F51 showed an unstable pressure pattern. The *hydro test* graph will most likely show a significant drop in pressure during the *holding* phase, indicating a leak between the *ball* and *the seat*. Prior to *lapping*, *the ball valve* F51 showed an unstable pressure pattern where at the beginning the pressure rose sharply at ±600 psi, decreased at ±300 psi, rose at ±850 psi, there was a drastic drop at ±300 psi, and at ±250 psi the *ball valve* was unable to maintain the test pressure. This decrease indicates the valve's failure to maintain pressure according to the standard.

However, after the repair, there was a drastic change in the pattern. Based on the data from Table 1.5, the post-repair graph shows a steady pressure increase from 0 to ±920 psi. The key pattern observed is a steady pressure at ±920 psi for 15 minutes (*holding* phase) without any fluctuations or decreases. This proves that the *lapping* process successfully creates a perfect *sealing* surface , eliminates leaks, and restores valve function.



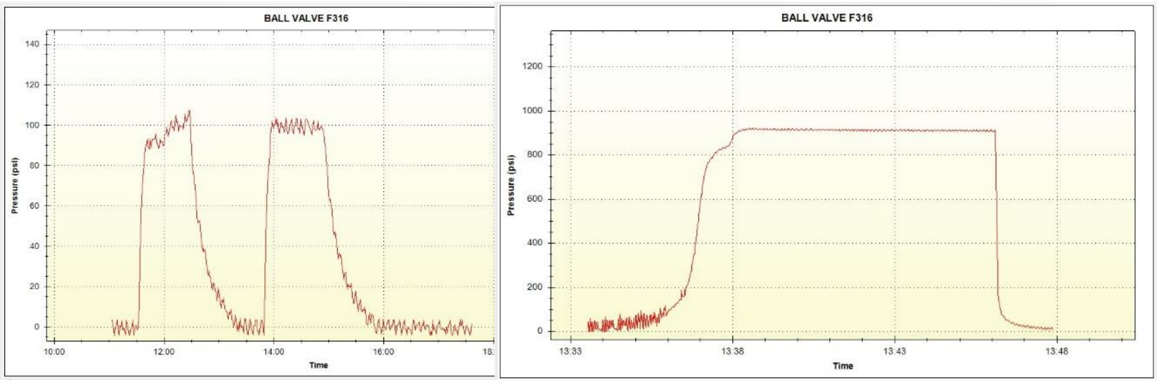
(a) (b)

Figure 1. 7 (a) Pressure Pattern Before Being Exposed *Lapping* (b) Pressure Pattern After At *Lapping Ball Valve* F51

Comparison of Pressure Patterns on Ball Valve F316

Similar to the F51, prior to the repair, the ball valve F316 also showed an inability to maintain the test pressure, as evidenced by a graph showing a gradual or rapid decrease in pressure. This pressure drop can be slower or faster, depending on the initial degree of damage to the *sealing surface*. In *the ball valve* F316 the pressure increases rapidly, but only reaches ±100 psi, the direct pressure drops rapidly at 0 psi indicates the presence of a leak or incapacitation of the *ball valve*, a second test is performed, only reaching ±100psi, and the pressure drop pattern repeats very quickly again drastically at 0 psi indicating the maximum test pressure is only around ±100psi.

After *the lapping improvement*, the pressure pattern on the F316 changed to stable, similar to that of the F51. The chart will show the pressure increase to the optimal value, followed by the *holding phase* where the pressure is successfully maintained constantly without leakage. This change in pattern from decline to stability underscores the effectiveness of the *lapping* method for F316 materials. *Ball valve* F316 in the *holding time phase*, stable pressure from 0 psi reaches a maximum figure of ±900 lasting for 15 minutes.



(a) (b)

Figure 1. 8 (a) Pressure Pattern Before Being Exposed *Lapping* (b) Pressure Pattern After At *Lapping Ball Valve* F316

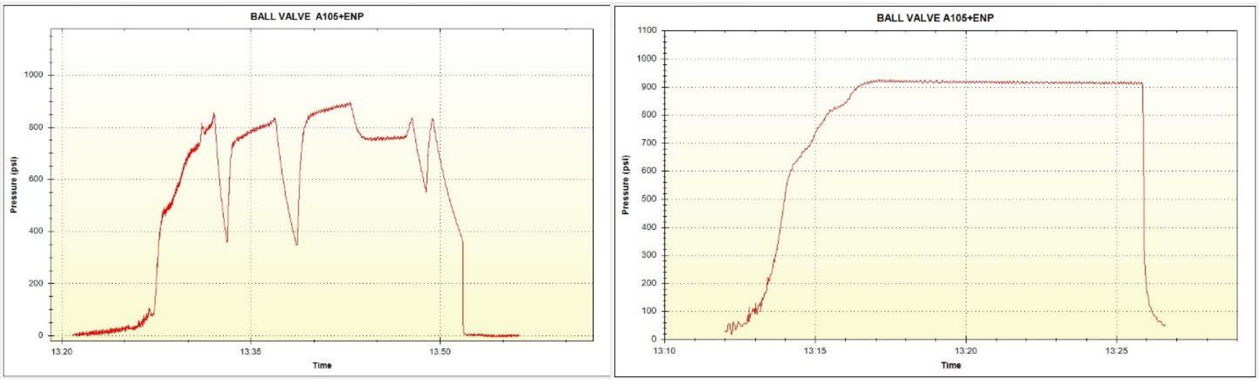
Comparison of Pressure Patterns on Ball Valves A105ENP

Before repair, the ball valve A105ENP also not able to maintain the test pressure. The *hydro test* graph will show a decrease in pressure during the *holding* phase, indicating a failure in the *sealing function.*

After repair, the pressure pattern changes significantly. Based on the data in Table 1.5, this valve successfully reached and maintained a pressure of ±910 psi for 15 minutes (*holding phase*). The explanation of the *sealing ball and the seat* working well confirms that the *lapping* repair has succeeded in creating precise surface contact, thus preventing leakage. This pattern proves that the corrective method applied is effective for *ball valves A105ENP.*

Discussion of Pressure Stability Trends Against Time

This section analyzes in depth the pressure stability trends found after repairs. This analysis serves to answer the formulation of the second problem, by making pressure stability the main indicator of the success of the repair.



(a) (b)

Figure 1. 9 (a) Pressure Pattern Before Being Exposed *Lapping* (b) Pressure Pattern After At *Lapping Ball Valve* A105ENP

Pressure Stability Trend *Ball Valve* F51

The graph of the hydro *test results* after the improvement on the F51 shows an excellent pressure stability trend. During the 10-minute *holding* phase, the pressure does not change from ±920 psi. This flat trend confirms that no leaks are detected, and the *sealing surface* resulting from the *lapping* process is able to withstand the test pressure load effectively. This stability indicates that the F51 material and *the lapping repair process* are compatible with each other.

Pressure Stability Trend *Ball Valve* F316

The hydro test *data* after the repair of the F316 also showed a positive pressure stability trend reaching a maximum of ±900. The chart will show a line that tends to be flat during the *holding* phase. This trend proves that the *lapping* process has improved the *sealing surface* of the *ball* and *seat*, so that leaks can be eliminated. This pressure stability indicates that F316, as a *stainless steel* material, responds well to *lapping treatment*.

Pressure Stability Trend *Ball* Valve A105ENP

The analysis shows a perfect pressure stability trend on the ball valve A105ENP after repair. The pressure persists constantly at ±910 psi during *the holding* phase, which proves that *the lapping* repair has successfully addressed the leakage problem that existed before. This trend directly shows that *lapping* repair is an effective and reliable solution to restore the *sealing* function of A105ENP material.

Relationship of Surface Conditions to *Hydrotest Pressure Results*

Based on the observations, it was determined that the surface condition after the *lapping* process showed an increase in smoothness and uniformity. This phenomenon significantly affects the results of hydrostatic tests, where the pressure is able to remain stable during the specified containment period. Surfaces characterized by reduced roughness increase the effectiveness between *the ball* and *the seat*, thereby reducing the occurrence of micro-leaks. In contrast, the rough surface in *pre-lapping* conditions creates air or water gaps that become a leaking path, causing a rapid drop in pressure. Overall, the superior the surface quality achieved through *lapping*, the greater the *ability of the ball valve* to maintain optimal working pressure.

Comparison with Previous Research Results

The test results in this study are in line with the results of the study by (TB. U. Adi Subekhi et al., 2024) which states that the pressure drop during the test *Hydrotest* is the main indicator of microleakage. However, in contrast to the study, the results obtained from this study show that the *Lapping* significantly improve *Sealing*, so that the pressure is maintained stably in the range of ± 900 psi.

In addition, research conducted by (Sebastian & Purwaningsih, 2021) Regarding the productivity of the machine *Lapping* also proves that improving surface quality through micro-smoothing has a direct influence on performance *sealing valve*. Thus, the results of this study provide corroborating observational evidence that shows a significant correlation between the level of surface smoothness after *Lapping* and pressure stability during hydrostatic testing.

CONCLUSIONS AND SUGGESTIONS

Conclusion

Based on the results of the research that has been carried out using ball valves F51, F316, A105ENP can be concluded as follows, that:

1. Pressure pattern before repair

   Prior to *lapping, the ball valve F51 showed an unstable pressure pattern where at the beginning the pressure rose sharply at ±600 psi, decreased at ±300 psi, rose at ±850 psi, there was a drastic drop at ±300 psi, and at ±250 psi* the ball valve was unable to maintain the test pressure. In *the ball valve* F316 the pressure increases rapidly, but only reaches ±100 psi, the direct pressure drops rapidly at 0 psi indicates the presence of a leak or incapacitation of the *ball valve*, a second test was performed, only reaching ±100psi, and the pressure drop pattern repeats again drastically at 0 psi indicating the maximum test pressure is only around ±100psi. In *the ball valve* A105ENP the pressure increases significantly, approaching the maximum value at ±200 - ±850, from ±850 the first sharp drop is drastically at ±300 psi, the pressure rises again at ±850 psi, the second drop is drastically at ±350 psi, the pressure is raised again at ±850 psi, the pressure decreases but not drastically at ±700 psi, the pressure is again raised at ±850 psi, Drastically reduced pressure, but slower than before at the ±400 psi ball valve was unable to maintain the test pressure.
2. Pressure pattern after repair

   After lapping, the *ball valve* F51 shows a pressure pattern that can reach a maximum of ±920 psi without any decrease, meaning it lasts for 15 minutes. *Ball valve* F316 in the *holding time phase*, the pressure is stable to reach a maximum of ±900 lasting for 15 minutes. In *the ball valve*, A105ENP maximum pressure is reached at ±910 psi and lasts for ±10 minutes.
3. Pressure stability trend

The *lapping* process successfully creates a perfect *sealing* surface , eliminates leaks, and restores valve function on all materials. The flat chart trend in the *holding phase* after the improvement confirms the excellent pressure stability, answering the formulation of the second problem regarding the pressure stability trend.

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