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Case Study of A Clear Stack Start-up on Oil Firing, Using "Hybrid" - Mechanical/Dual Medium Atomizers

Storm Technologies, Inc. takes pride in providing solutions to problems. This month we have decided to focus on Oil Firing for Start-Up, and minimizing opacity as well as oil droplet carry-over into the electrostatic precipitator. The boiler on which this case study is written, is a 45MW coal fired unit, with six wall mounted burners. Turbine warm-up and initial loading was accomplished by the use of heavy oil (#6 oil) supplied to the "Hybrid" Dual Medium/ mechanically atomized burners. Before modifying, the burners were straight mechanical with a nominal 900 psig supply and 600 psig return (300 psi Δp).

The problem was fourfold: (1) The fires were dirty, smudgy, with long flames and oil mist carryover into the airheater and ESP. (2) Stack opacity was a problem. (3) ESP performance was poor until the oil mist and carbon soot particles were removed. Sometimes this took over a week of coal operation. (4) The risk of air preheater fires was real and significant. The facts of the matter are, that based on my personal experiences a clear upper furnace, smoke free, with low stack opacity has never been possible during a cold start-up using straight mechanical atomizers.

High Performance Dual Medium Atomizer

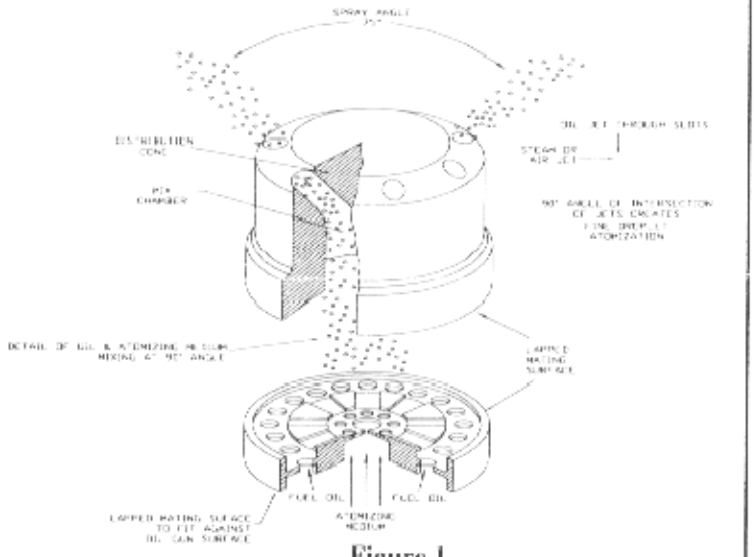
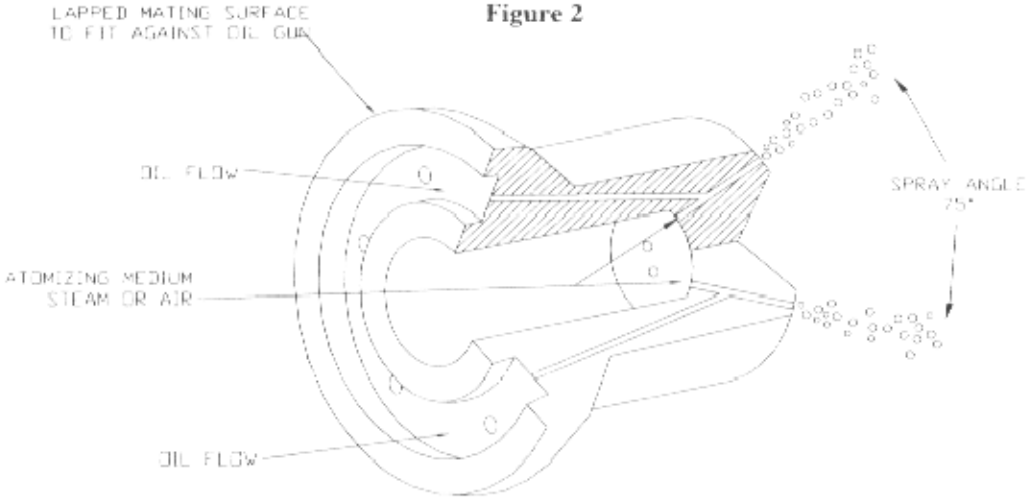


Figure 1

When the customer asked "what can we do to start this boiler using #6 oil and have acceptable stack opacity? Here is the solution that we suggested and ultimately used successfully: The mechanical atomizers used a constant differential supply return piping arrangement, with several hundred psi differential across the atomizer tip, satisfactory for high load operation, but not

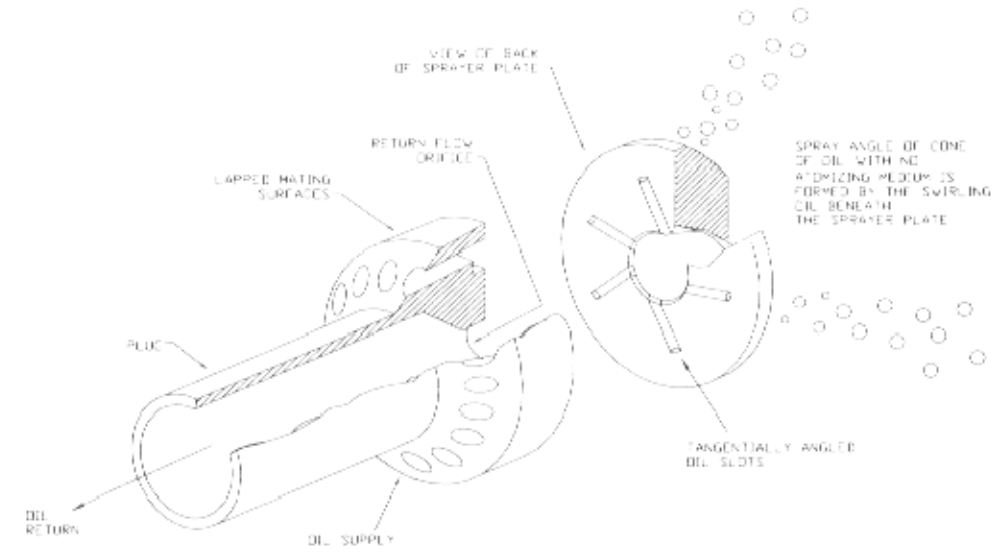
Figure 2



Steam Or Air Assist Type Atomizer

acceptable for start-up conditions. The "Hybrid" approach was to use the highly effective, high energy dual medium atomizer, shown on Figure 1, for start-up. This atomizer is the most effective, for sharp, clear flame development. The straight mechanical atomizers, as used on this case study, have the intrinsically least effective atomization. Two inherent characteristics make it difficult to achieve clean combustion in a cold furnace. The first is the oil droplet size (less effective atomization) is larger. The second is the spray angle of the oil varies with the amount of fuel recirculation under the tip. For example, to achieve 4:1 turn down, the oil supply at full rating may have 10-25% return flow, and 75-90% of the oil supply being discharged into the furnace. At low firing rates the return flow is perhaps 75-90% of the supply flow, and 10-25% being discharged into the furnace. This inherent characteristic of the single exit hole oil burner tips in my experience, often causes a varied spray angle. The combination of these two factors that are intrinsic in the design, make it difficult to achieve well developed flames with complete combustion. As background, perhaps a brief review of the basic three types of oil gun atomizers will be useful. The next best to the High Performance Dual Medium Atomizer on page one is the steam or air assist or "Y" jet type atomizer (This is shown above, on Figure 2). The "Y" jet atomizer uses between 1/3 and 1/2 of the atomizing medium of the High Performance atomizer. Oil droplet size consequently, is slightly larger, and furnace residence time, air turbulence and air/fuel mixing of the burner design are that much more important considering the less effectiveness of the "Y" jets atomization effectiveness.

Figure 3

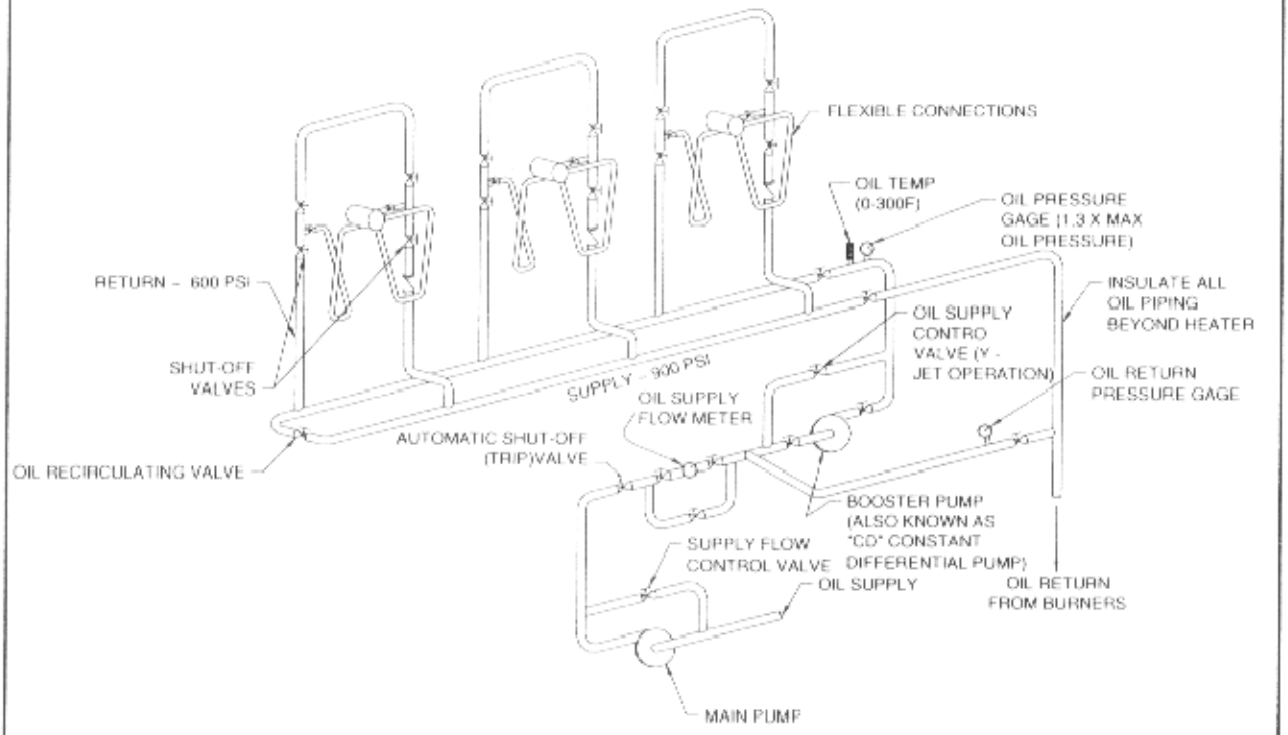


Mechanical Atomizer

A fair question is, if the mechanical atomizers are so poor, then why are they used? The answer is that atomizing steam or compressed air is an operational cost that can be significant. For example, highly effective dual medium atomizers (The "Best" atomizers) use the most atomizing medium. "Excellence in atomization effectiveness" comes with a cost. Compressed air consumption may be as high as 0.25 lbs. of air per pound of oil. Atomizing steam consumption may be as high 0.15 #'s of steam per pound of oil. (One fact often overlooked, is that air is more dense than steam, and has improved atomization effectiveness because of the higher density.) The steam consumption can use as much as 1% of a boilers total steam production when the numbers are worked out. So mechanical atomizers are attractive for sound boiler efficiency (and water consumption) reasons. However, they are no match for atomization effectiveness of optimally designed compressed air or steam atomizers. To give you an idea of how much compressed air it takes for effective atomization. Here is an example: 300 million BTU heat input which is about 36 gallons per minute of oil flow (16,200 #/hr). The compressed air consumption will be about 1,000 SCFM at 150 to 200 psi supply pressure.

So, you see "why" designers like the mechanical atomizers for full load operation. The solution for Start-up can be a "hybrid", an old word that is used quite a lot these days. The Hybrid Mechanical/Dual Medium Atomizer Arrangement for Start-up was accomplished using supervised manual control. Figure 4 below shows a typical piping arrangement of a constant differential mechanical fuel atomizer system.

Figure 4 Typical Mechanical Atomizer System



The mechanical atomizer, as shown on Figure 3, would use a supply-return piping system such as Figure 5 below.

Figure 5 Simplified Straight Mechanical Atomization Piping System

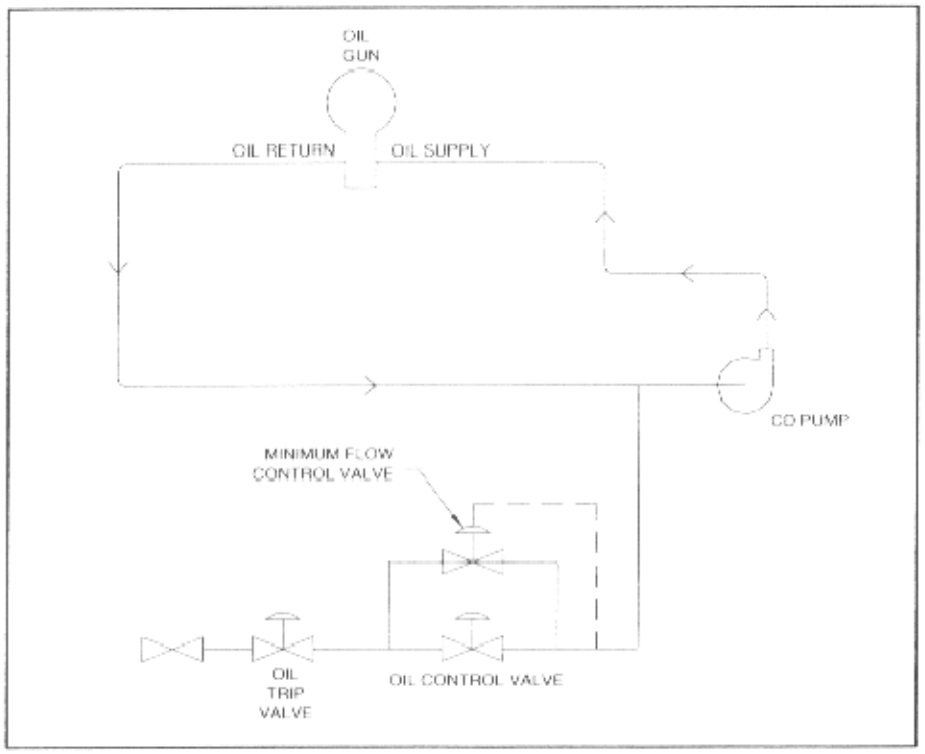


Figure 6 Hybrid Mechanical /Dual Medium System

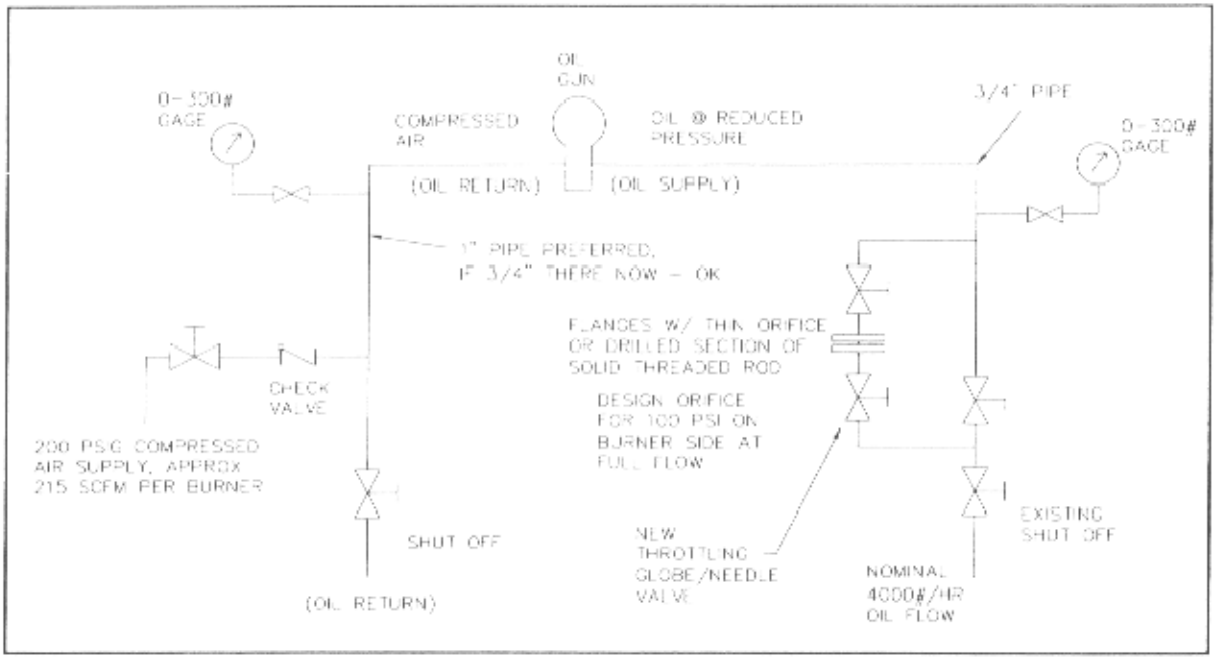


Figure 6, on the previous page, shows the basic arrangement that was used to eliminate the dirty start-up flames. The Hybrid atomization was accomplished by using an orifice to reduce the high oil supply pressure, and the use of compressed atomizing air for clean start-up fires.

For a clear stack during a cold Start-up, the piping is arranged to use compressed air atomization for sharp clean flames. Then, after the furnace is hot and the turbine loaded above minimum, other burners are placed in service in the mechanical atomization mode. Thus, providing the advantages of both a cleaner stack at cold Start-up and more efficient operation of the mechanical atomizers, at high loads.

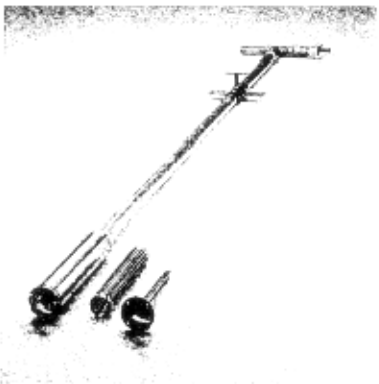
This is an example of some of the innovative thinking the engineers at Storm Technologies, Inc. have come up with, and cost effectively applied to solve "problems". Our customers problems are our opportunities and we take pride, and derive great satisfaction in sharing our expertise with our customers. Our specialty is coal firing. However, as Power Generation and Combustion Specialists, we have done considerable work on Boilers and Combustion Systems using gas, oil, coal, biomass, MSW and petroleum coke.

We thought that a short case study on Oil Firing would be an interesting switch from our "normal" Newsletter subject of Pulverized Coal Combustion Optimization. For more information on our company, visit our web site at www.stormeng.com.

With all best wishes for low heat-rates, clear stacks and high reliability, I remain Sincerely yours,

Dick Storm
President

Determine Your Fuel Oil Additive Dosage Rate



Speaking of oil firing, one tool useful for the tuning of oil fired boilers is our STORM® Insitu Flyash Sampler in conjunction with sub-micron pore size high-temperature filter paper.

Insitu Flyash Sampler includes: sample canister, nozzle tip, perforated cylinder, 50 Reg. filter paper for back-up and 100 sheets of 800°F rated 0.3 micron pore size filter paper, aspirator assembly, optional pipe length, required air connection fitting and procedures.

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