GLOBAL WATER SOLUTIONS LTD.

Global Water Solutions Engineering Memo

To: whom it may concern
From: Robert Lombari
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Reference: Energy Consumption Comparison with Relation to Tank Sizing

The purpose of this article is to examine the relation between pressurized tank size in a pressurized water system and energy consumption. The systems to be reviewed include elevated storage re-pressurization and differential control systems utilizing pressurized tank storage.

In elevated storage systems low pressure pumps are asked to deliver and maintain a high low level in an elevated reservoir. These types of systems are used extensively throughout the world to deliver gravity fed water to household demands. Benefits of such system include ample water storage from low yield supplies, a wide low to high level setting permitting longer pump delivery and fewer starts. These systems operate very economically and perform well where water supplies are limited; however elevated delivery systems are not to be confused with pressurized water systems. Elevated delivery can only deliver marginal pressures which are restricted by reservoir elevation; delivery pressure at reservoir elevations is restricted to reservoir depth. These elevated systems can be utilized for water storage in low supply situations but in order to be considered a pressurized water system, for the points of this article, must be repressurized with an additional supply pump. Because the pressurized system is governed by the supply pump it can be said that elevated reservoir systems are to be considered inclusive to the pressurized water systems consider in this article.

It is stated that elevated reservoirs are economical, in reviewing this statement; the energy consumed to lift the water to the higher elevation is the work being done. This work is stored as energy in the elevated reservoir and is released in the form of pressure determined by the lift. The energy storage is best realized when the stored water is used at the original ground level and pressure is at a maximum without the use of a supply pump, any stored water that is utilized at an elevation between the stored water and ground level contains only the portion of energy required to satisfy demand at that point . The benefit of the reservoir is also realized in the energy consumption needed to maintain the reservoir level, reservoirs can be sized in a way that will allow minimal pump starts (wasted energy) and long pump run times (stored energy) for refilling of the reservoir. A quick evaluation indicates that the larger the reservoir the more energy can be stored with fewer pump starts and the pump operation will be more efficient due to the fact that a low energy pump can be sized to perform over a longer period of time. This concept will be carried over to the supply/booster pump required to maintain a pressurized water system.

In differential control pressurized water systems a supply pump is used to deliver pressurized water directly to the point of demand, the prepressurized tank will act as an elevated reservoir in that pump energy is stored in the form of water pressure and elevation is replaced with a permanent air charge, there is no need for an elevated water reservoir as long as sufficient water volume is available. The supply pump will perform at the highest efficiency when running and delivering at an optimum output on the pump pressure flow curve. Energy needed at pump start is consumed in overcoming inertia and is lost to heat; this can not be recaptured in any way. This start up energy consumption is the least efficient energy in delivering to the purpose of the system, pressurized water. This inefficiency is manifested in heat at the pump motor and can be detrimental to the motor of the pump. The motor manufacturer's maximum starts per hour recommendations are calculated to prolong motor life but not to optimize energy efficiency. In these systems a pressurized tank is used in order to minimize pump starts and provide stored pressurized water for short demand periods. The pumps in a differential system are commonly sized for maximum demand and will be most efficient when operating at these levels; the variable becomes the demand, both in duration and quantity. The pressurized tank has become an energy storage devise which will allow the pump to operate at optimum levels by accepting the excess energy of the pump during demands that are below the optimum demand level. When the demand is at optimum levels the pump will supply the demand efficiently, when demand is below the optimum level the pressure tank will receive the excess energy in the form of pressurized water (as elevated storage tanks do) maintaining the optimum operating level of the pump.

In differential control pressurized water systems the tank size must be sufficient to reduce the number of pump starts to within the pump manufacturers starts per hour in order to maintain pump reliability and performance; this is done in the form of stored energy as pressurized water. When the tank is sized appropriately the pump start energy manifests itself as heat or wasted energy that is normally absorbed into the water of the system. It is logical that the fewer pump starts the less wasted energy. Pump starts can be reduce by storing larger amounts of water at pressure to satisfy the demand without starting the pump and by providing a means of storing the unneeded energy when the pump is delivering to a low demand.

By example; in a pressurized water system a pump is sized to deliver to the maximum demand of 40 liters per minute and requires a run time of 1 minute and a lay time of 1 minute. This schedule would provide for 30 pump starts per hour under any system flow condition, the energy consumed for pump starts will be lost in the form of heat. When the system is operating at full flow then the pump will run continuously after starting, when operating at partial flow the excess energy used by the pump will be stored in the pressurized tank. When we consider the same system with a tank two time larger, pump starts will be reduced by half and the heat energy used to start the pump will be divided over a larger volume of stored pressurized water (stored energy). The more energy that can be efficiently stored for each pump start will result in reduced energy consumption due to the fact that less energy is used in the form of heat.

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