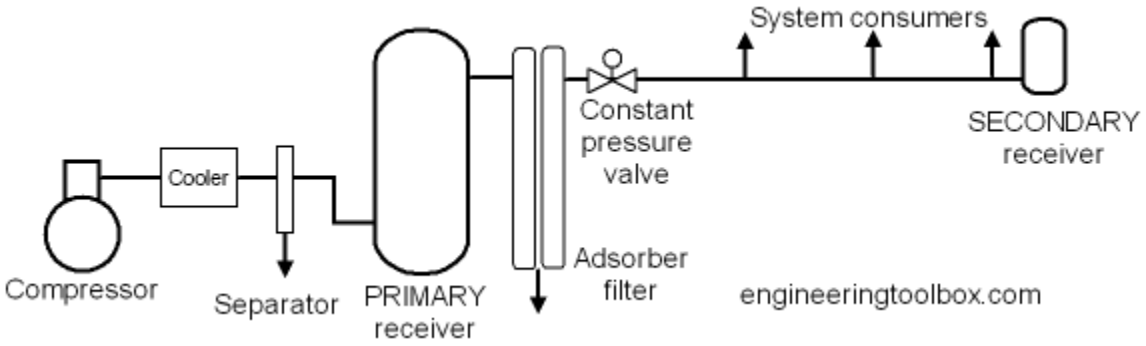
Calculating receivers in compressed air systems

An air receiver is essential to every compressed air system to act as a buffer and a storage medium between the compressor and the consumption system. There are in principal two different air receivers in a compressed air system:

- PRIMARY receiver - is located near the compressor, after the after-cooler but before filtration and drying equipment
- SECONDARY receiver - is located close to the point of large intermittent air consumption



The maximum capacity of the compressor in a well designed systems always exceed the **maximum mean air consumption** of the system (maximum mean air consumption is the mean air consumption over some reasonable time).

Since the maximum capacity of an air compressor also always exceed the minimum air consumption in the system - the compressor must modulate its capacity during normal work, often by using primitive strategies as on/off modulating or more advanced strategies as frequency drives and inverters. Primitive modulating strategies cause more pressure variations in compressed air systems than more advanced strategies.

In addition, the air consumption vary due to the process supported. In shorter periods the demand for compressed air may even exceed the maximum capacity of the compressor. In fact, it is common in well designed systems not to design the compressor for the maximum peek loads.

Air receivers in compressed air systems serves the important purposes of

- **equalizing the pressure variation** from the start/stop and modulating sequence of the compressor
- **storage of air volume** equalizing the variation in consumption and demand from the system

In addition the receiver serve the purpose of

- **collecting condensate** and water in the air after the compressor

Sizing the Air Receiver

The air receiver must in general be sized according

- the **variation in the consumption** demand
- the compressor size and the **modulation strategy**

In general it is possible to calculate the maximum consumption in the system by summarizing the demand of each consumer. The summarized consumption must be multiplied with a **usage factor** ranging 0.1 to 1 - depending on the system. In practice it is common that the manufacturer use standardized receivers for specific compressor models based on their know-how.

For calculating the receiver, note that it is necessary with a **pressure band** for the receiver to be effective. If the consumption process requires 100 psig and the compressor is set to 100 psig, there is no storage and no buffer. Any increased demand makes a pressure drop below 100 psig until the compressor controls respond by increasing the volume compressed.

If the compressors operates at 110 psig the difference between 110 and 100 psig accounts for the air stored in the receiver. If the demand increase, the pressure can drop 10 psig before the minimum requirement is met. Pressure and flow controllers can be used after the receiver for stabilizing downstream pressure to 100 psig and flattening demand peaks. Note that in a compressed air system the pipe work also makes the purpose of a buffered volume.

The receiver volume may be calculated with the formula

$t = V (p_1 - p_2) / q_s p_a$ (1)

where

V = *volume of the receiver tank (cu ft)*

t = *time for the receiver to go from upper to lower pressure limits (min)*

q_s = *free air flow (scfm)*

p_a= *atmospheric pressure (14.7 psia)*

p_1 = *maximum tank pressure (psia)*

p_2 = *minimum tank pressure (psia)*

It is also common to size receivers

- to 1 gallon for each ACFM (Actual Cubic Feet per Minute), or
- 4 gallons per compressor hp (horse power)

Airflow Capacity		Recommended Receiver Volume		
(cfm)	(m3/h)	(cu ft)	(gal)	(m3)
100	170	13	100	0.4
200	340	27	200	0.8
300	510	40	300	1.1
400	680	54	400	1.5
500	850	67	500	1.9
750	1275	101	750	2.9
1000	1700	134	1000	3.8
1500	2550	201	1500	5.7
2000	3400	268	2000	7.6
3000	5100	402	3000	11.4
4000	6800	536	4000	15.2
5000	8500	670	5000	19.0
7500	12750	1005	7500	28.5
10000	17000	1340	10000	38.0

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Compressor Power		Recommended Receiver Volume		
(hp)	(kW)	(cu ft)	(gal)	(m3)
5	3.7	3	20	0.1
7.5	5.6	4	30	0.1
10	7.5	5	40	0.2
15	11.2	8	60	0.2
20	14.9	11	80	0.3
25	18.7	13	100	0.4
30	22.4	16	120	0.5
40	29.8	21	160	0.6
50	37.3	27	200	0.8
60	44.8	32	240	0.9
75	56.0	40	300	1.1
100	74.6	54	400	1.5
125	93.3	67	500	1.9
200	149.2	107	800	3.0
350	261.1	188	1400	5.3
450	335.7	241	1800	6.8
500	373.0	268	2000	7.6

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Note! Receivers of unsound or questionable constructions may be very dangerous.

Fuente: The Engineering Tool Box