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(54) Surge control system.

(57) A surge control system for dewatering press felts on a papermaking machine which includes a suction pipe (12), a variable speed drive motor (38), a centrifugal exhauster (26) driven by the variable speed drive motor and connected to the suction pipe to provide vacuum to a felt (14) passing over a slot (18) for dewatering thereof. A surge valve (28) is provided and is opened to admit air to the centrifugal exhauster (26) so as to prevent surge when the centrifugal exhauster is operating at a predetermined level at which the centrifugal exhauster will surge.

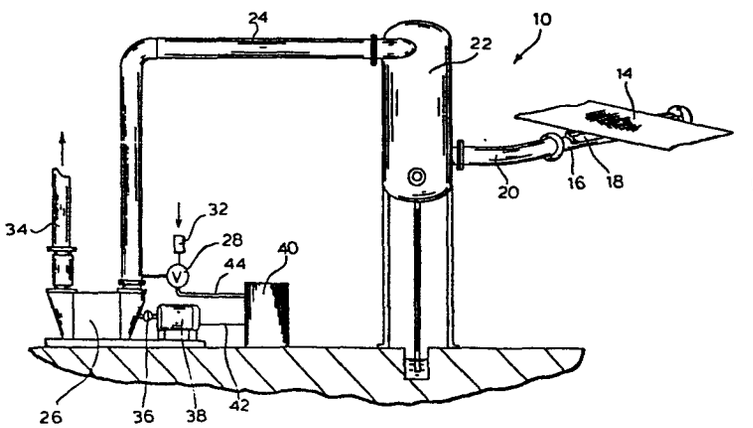

FIG.1

Surge Control System

The present invention relates to a surge control system, in particular for use in a variable speed electric drive for a centrifugal exhauster such as that utilized in dewatering applications.

It is well known in the papermaking industries to use vacuum or suction pipe systems in dewatering. Such systems often utilize suction pipes coupled to elongated suction slots over which a felt passes causing the dewatering thereof. In systems of this type, a variety of devices are available to provide the vacuum necessary for dewatering. For example, liquid ring pumps, positive displacement pumps and centrifugal exhausters or blowers. While many circumstances and operating parameters dictate which type device is best suited for a particular application, a common desire in the selection of a vacuum pump is that it be efficiently incorporated and utilized in the system.

In this regard, generally the vacuum pumps are sized for maximum demand vacuum conditions in the suction pipe when the felt is new. The vacuum pump will normally run at its maximum speed with a new felt. As the voids in the felt fabric are filled during use, the fabric becomes less permeable and so requires a higher vacuum level for dewatering. However, with the decreased felt permeability and, since the vacuum pump is a constant volume unit, the vacuum level will automatically increase.

Many systems have been devised to take advantage of increasing vacuum conditions to effect

cost and energy savings. See for example US Patent Nos. 4,308,077, issued December 29, 1981; 4,329,201, issued May 11, 1982; and 4,398,996, issued June 19, 1981. For example, in the variable vacuum liquid ring pump having constant flow, described in US Patent No. 4,398,996, a variable speed drive motor responsive to an increase in the vacuum level in the suction pipe is provided. The motor is operative to slow down the vacuum pump as the felt permeability decreases, thereby retaining the desired level in the suction pipe. The lower pump speed results in lower drive horsepower and accordingly a saving in power, while retaining the desired vacuum level in the suction pipe. Similarly, when a centrifugal exhauster is used as the vacuum device, it has also been proposed that the speed of the exhauster should be automatically regulated as the permeability of the felt decreases.

While known arrangements have proven satisfactory in certain applications, it is desired to provide for yet further efficiency and energy savings in a dewatering system, particularly one that utilizes a centrifugal exhauster or blower as compared to a positive displacement unit.

In all exhauster arrangements, the occurrence of surge can have a serious and often damaging effect on the system. While many different type surge controls are available, it is desirable to have an automatic surge control that could be effectively employed in the situation in which a variable speed drive with a centrifugal exhauster is used in papermaking applications: in such a situation, there is no specific signal that can be used to sense surge because the surge points change with speed.

It is, therefore, an object of the invention to provide an automatic surge control system for a variable speed drive centrifugal exhauster used in dewatering applications.

It is another object of the invention to provide such a surge control which is of comparatively simple and inexpensive construction. According to the present invention a surge control for dewatering press felts on a papermaking machine comprises of a suction pipe; a variable speed drive motor; a centrifugal exhauster driven by the variable speed drive motor and connected to the suction pipe to provide vacuum to a felt passing over a slot for dewatering thereof, and whereby as the felt permeability and air flow demand decrease, the drive motor increases the speed of the centrifugal exhauster up to a predetermined maximum speed; control means coupled to the centrifugal exhauster for determining when the predetermined maximum speed occurs, said control means being coupled to said drive motor for monitoring when a predetermined load on the drive motor occurs at which the centri-exhauster when operating at maximum speed will surge, and a surge valve for admitting air to the centrifugal exhauster, said control means being coupled to said surge valve and operative in signalling said valve to admit air to the centrifugal exhauster when said centrifugal exhauster is operating at the predetermined maximum speed and the drive motor has predetermined load thereon so as to prevent the centrifugal exhauster from going into surge.

Additionally the invention provides a method of controlling surge in papermaking machines for de-

watering press felts including a suction pipe, a surge valve, a variable speed drive motor, a centrifugal exhauster driven by the variable speed drive motor and connected to the suction pipe to provide vacuum to a felt passing over a slot for dewatering thereof, and whereby as the felt permeability and air flow demand decrease, the drive motor increases the speed of the centrifugal exhauster, the method comprising: limiting the speed of the exhauster to a predetermined maximum speed; determining when the predetermined maximum speed of the centrifugal exhauster occurs; monitoring when a predetermined load on the drive motor occurs at which the centrifugal exhauster when operating at maximum speed will surge; and opening the surge valve to admit air to the centrifugal exhauster when said centrifugal exhauster is operating at the predetermined maximum speed and the drive motor has a predetermined load thereon so as to prevent the centrifugal exhauster from going into surge.

An embodiment of the present invention will now be described with reference to the accompanying drawings in which:

Fig. 1 is a schematic view of a vacuum control system as part of a section of a papermaking machine, and

Fig. 2 is a representative performance curve for a particular variable speed centrifugal exhauster.

The depicted portion 10 is of a well known type of papermaking machine which utilizes one or more suction pipes 12 for dewatering a press felt 14 or similar fabric. The use of several suction pipes is discussed in US Patent No. 4,329,201. This is a

common arrangement at the press section of the papermaking machine.

The typical suction pipes 12 include a hollow conduit 16 with a slot 18 forming an opening in its upper end over which the felt or fabric passes. An exit conduit 20 passes to a conventional type of liquid and gas separator 22. The separator 22 has a bottom exit for passage of separated liquid into a seal pit through a drop leg. The separator 22 is in turn connected by conduit 24 to a vacuum pump 26, which is a centrifugal exhauster type. Such exhauster may be of the type manufactured by Hoffman Air & Filtration Systems, a division of Clarkson Industries, Inc., PO Box 214, Eastwood Station, Syracuse, New York 13206. For general background material on exhausters see Publication CBE-378 entitled "Centrifugal Blowers and Exhausters" put out by the aforenoted company.

Typical in such systems, a relief or surge valve 28 is positioned between the separator 22 and the exhauster 26 for vacuum and surge release purposes when needed. Silencers 32 and 34 are also provided.

A conventional drive shaft 36 interconnects a variable speed drive means 38 with the exhauster 26 to adjust and drive it at a chosen variety of speeds as is hereinafter discussed.

Note that the drive means 38 is a variable speed drive AC motor and may be of the type manufactured for example by Reliance Electric, 24703 Eucled Avenue, Cleveland, Ohio 44117 (A-C VS Drives; Duty Master-XE; AC Motors; and Max Pak plus); Toshiba Corporation 13-12 Mita 3 chrome, Minato-ku, Tokyo, Japan (MF Pack); Toshiba/Houston Inter-

national Corporation, 13131 West Little York Road, Houston, Texas 77041 (ESP-130 series); Parametics, Orange, Connecticut.

The drive means 38 is coupled to a control panel 40 via connection 42 which may be electrical wiring. The control panel 40 is coupled through connection 44 to surge valve 28 which in turn is coupled to conduit 24.

As noted, air flow through a felt decreases with use. Heretofore, in a positive displacement unit, reducing the speed of the vacuum pump with decreasing felt permeabilities provided an advantageous way to save drive power since the power requirement of the pump is a function of its speed. Typical variable speed drives are normally set up to run at a maximum speed and then as the demand decreases, its speed automatically slows down.

With a centrifugal exhauster, such a method of operation is not desirable since, if the speed of the exhauster is decreased, the vacuum level will decrease (instead of remaining constant as would be the case with a positive displacement unit).

So, rather than slowing the speed of the exhauster 26 down, the variable speed motor 38 speeds up as the felt permeability decreases thereby producing a higher vacuum at the suction pipe 12. Since the air flow through the felt is less, a higher vacuum at a lower air flow is possible by speeding up the exhauster while maintaining the same torque or drive power.

The system allows the exhauster to run at a variable speed to meet the required vacuum at the suction pipe to dewater a felt as it goes from new to old rather than throttling the air flow by

turning down a valve as was done heretofore with constant speed exhausters. Such a drive system also allows for the automatic adjustment of the exhauster during dewatering of multigrade webs for example light webs at slower speeds; and heavier webs at higher speeds.

When an AC motor is utilized in such a system, the speed of the motor can be varied by varying the AC frequency delivered to the motor. This is a standard feature in many of the models of AC motors mentioned previously.

The operation of the drive motor 38 may be automatically controlled using a feedback loop arrangement regulating the frequency and/or current at the desired level. The maximum speed of the motor is limited, to prevent overloading, by setting the maximum current (or current frequency) or by setting the maximum speed.

As aforenoted, the voids in a felt fabric fill and it becomes less permeable (scfm flow decreases) with use, causing the vacuum level required for dewatering to rise. The term "scfm" means - standard cubic feet per minute of air -. With a constant flow, variable vacuum liquid ring style pump, the horsepower increases as the vacuum level increases with use of the felt fabric. However, with the centrifugal exhauster 26 of Fig. 1, as the air flow decreases through the fabric with use, the horsepower decreases.

With the variable speed drive arrangement 38 of Fig. 1, the speed of the exhauster 26 automatically increases as the air flow demand decreases. Fig. 2 shows the performance curve for a variable speed exhauster and shows that, as the speed of the exhauster varies, so do the surge points. Since the horsepower (hp) at the surge point varies at

different rpms, as shown, a monitoring thereof is insufficient since there would be no specific signal which would indicate that the exhauster is entering a surge region.

However, in the system shown in Fig. 1, the speed of the exhauster automatically increases as the air flow demand decreases. Therefore, the exhauster cannot go into surge until after it reaches its maximum speed, which is predetermined based upon the particular application, and use is made of this to prevent the exhauster going into surge, as described below.

More particularly, by monitoring the exhauster at its maximum speed via the control panel 40 and determining when the power, current or frequency drops below a predetermined amount, the control panel 40 signals the surge valve 28 to open and admit air to the exhauster 26 to prevent further reduction of air flow, so preventing the exhauster 26 from going into surge.

For example (referring to Fig. 2), if the exhauster 26 has a maximum speed of 4200 rpm then, at approximately 82 hp and below, the exhauster will be in its surge region. Accordingly, when the control panel 40 senses an exhauster speed of 4200 rpm and monitors a horsepower output of the variable drive motor 38 that is less than or equal to 80 hp, it signals the surge valve 28 to permit air to be admitted to the exhauster so preventing a further reduction of air flow and the exhauster from going into surge. As the horsepower increases to a level greater than or equal to 82 hp, the control panel signals the surge valve to close. The dead band control region, which in this case is the range

80 to 82 hp, is used to prevent valve "hunting".

The maximum speed will vary upon the particular exhauster involved and the application. The performance curve for the particular maximum speed is readily available from the manufacture. Rotational sensors for monitoring the speed of the exhausters are also available along with the monitor for the power output of the variable drive engine. Alternatively, as indicated above, the current demand of the motor or frequency can be monitored instead of horsepower.

Operation of the system described above can be summarized as follows. The speed of the exhauster 26 automatically increases as the air flow demand (ie, at the suction slot 18)decreases due to a change in felt permeability. If for example, the suction slot 18 was completely shut off, the exhauster 26 would automatically speed up to its maximum speed. With such an arrangement, it is determined that the exhauster 26 cannot go into surge until after it reaches its maximum speed setting. Therefore, surge need only be controlled at the maximum speed of the exhauster.

When the exhauster 26 is operating at its maximum speed, the power it demands becomes less as the air flow decreases. To prevent damage due to surging, the control panel 40 senses when the exhauster is running at maximum speed and when the power (hp), current draw (amp) or frequency drops below a predetermined amount. Thereupon, the control panel 40 causes the surge valve 28 to open to admit air to the exhauster 26 to prevent further reduction of air flow, thus preventing the exhauster from going into surge.

Claims

1. A surge control system for dewatering press felts on a papermaking machine which includes a suction pipe; a variable speed drive motor; a centrifugal exhauster driven by the variable speed drive motor and connected to the suction pipe to provide vacuum to a felt passing over a slot for dewatering thereof, and whereby as the felt permeability and air flow demand decrease, the drive motor increases the speed of the centrifugal exhauster up to a predetermined maximum speed; control means coupled to the centrifugal exhauster for determining when the predetermined maximum speed occurs, said control means being coupled to said drive motor for monitoring when a predetermined load on the drive motor occurs at which the centrifugal exhauster when operating at maximum speed will surge, and a surge valve for admitting air to the centrifugal exhauster, said control means being coupled to said surge valve and operative in signalling said valve to admit air to the centrifugal exhauster when said centrifugal exhauster is operating at the predetermined maximum speed and the drive motor has predetermined load thereon so as to prevent the centrifugal exhauster from going into surge.

2. A system in accordance with claim 1 wherein said variable speed drive motor is an AC motor and said control means monitors the load thereon by monitoring current demand or frequency or horsepower of the motor.

3. A papermaking machine including a system in accordance with claim 1 or claim 2, the system being arranged to dewater a press felt.

4. A method of controlling surge in a paper-making machine for dewatering press felts which includes a suction pipe, a surge valve, a variable speed drive motor, a centrifugal exhauster driven by the variable speed drive motor and connected to the suction pipe to provide vacuum to a felt passing over a slot for dewatering thereof, and whereby as the felt permeability and air flow demand decrease, the drive motor increases the speed of the centrifugal exhauster, the method comprising: limiting the speed of the exhauster to a predetermined maximum speed; determining when the predetermined maximum speed of the centrifugal exhauster occurs; monitoring when a predetermined load on the drive motor occurs at which the centrifugal exhauster when operating at maximum speed will surge; and opening the surge valve to admit air to the centrifugal exhauster when said centrifugal exhauster is operating at the predetermined maximum speed and the drive motor has a predetermined load thereon so as to prevent the centrifugal exhauster from going into surge.

5. A method in accordance with claim 4 which includes the steps of providing an AC motor as the drive motor and monitoring the load thereon by monitoring current demand or frequency or horsepower of the drive motor.

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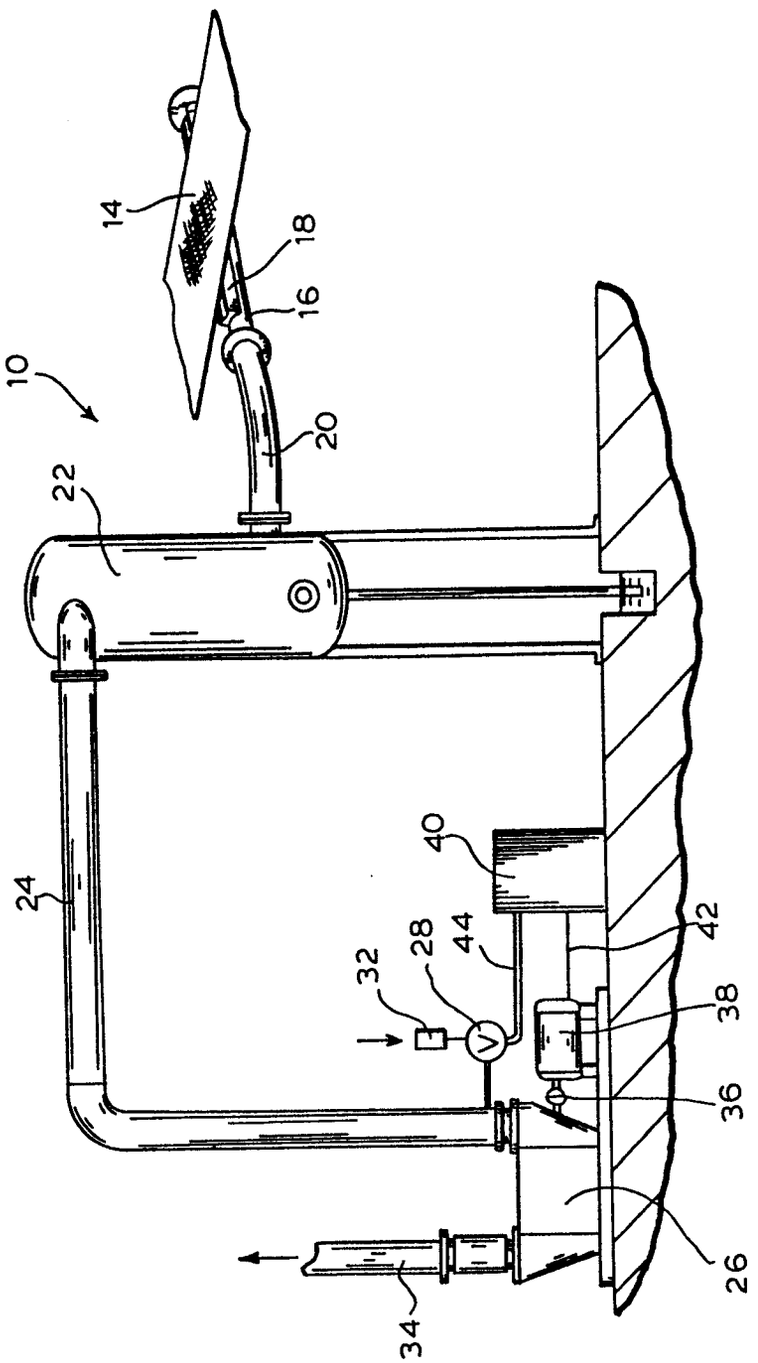

FIG.1

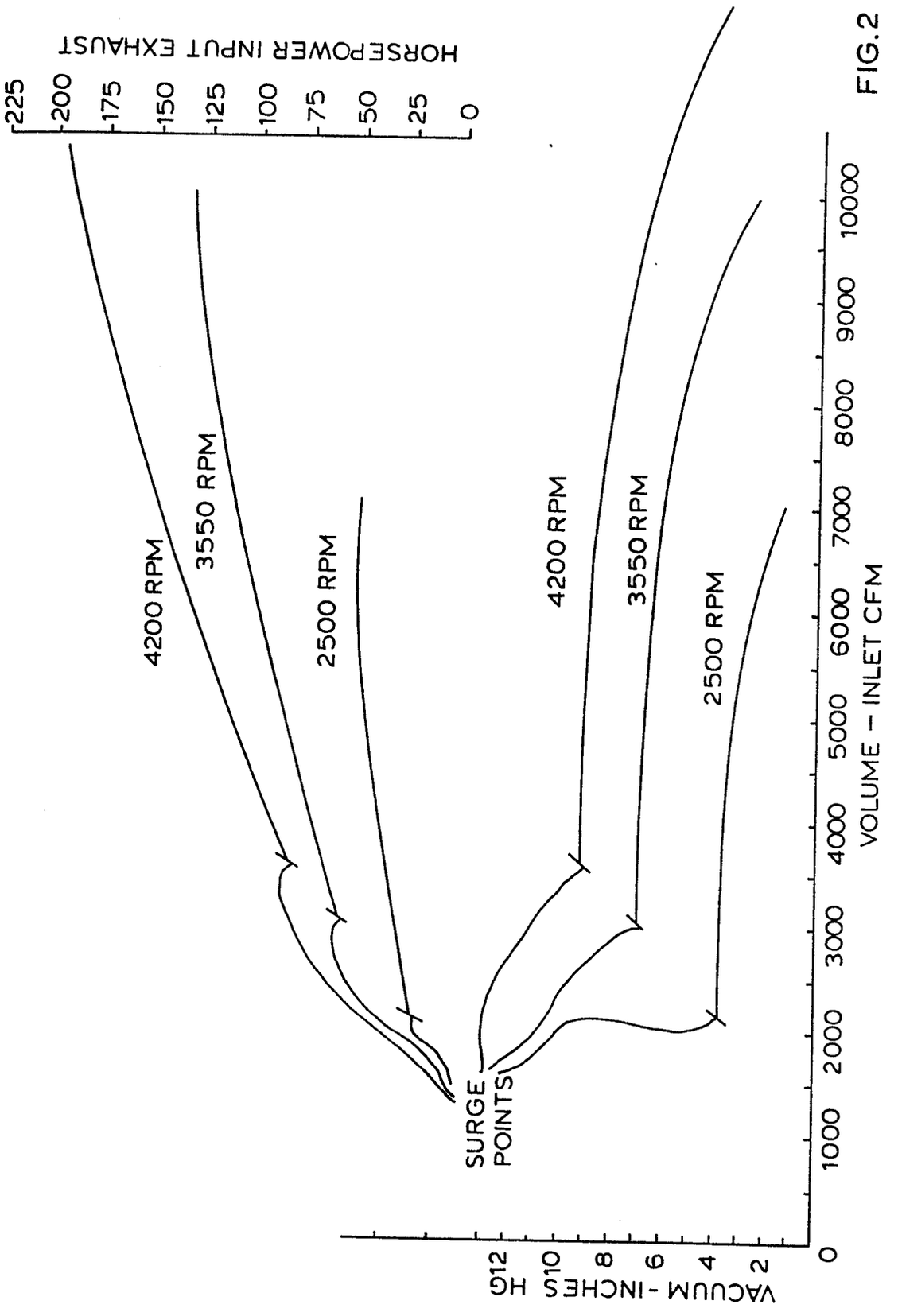
HORSEPOWER INPUT EXHAUST
225
200
175
150
125
100
75
50
25
0
4200 RPM
3550 RPM
2500 RPM
SURGE POINTS
4200 RPM
3550 RPM
2500 RPM
VACUUM - INCHES HG
12
10
8
6
4
2
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
VOLUME - INLET CFM

FIG.2