Incinerator Buckets and Grapples

Abstract

The two types of buckets used in incinerator service today are the closed scoop type and the tine type. Each has inherent advantages and disadvantages. To choose the proper type and model of bucket for a particular application, one should be thoroughly familiar with and be able to evaluate all the components going into its makeup. Only by a complete and thorough analysis of all factors affecting the bucket will the prospective purchaser be assured of securing the best unit for his installation.

Types of Buckets

There are two types of bucket commonly used in incinerator service, the closed scoop type and the tine type. For purposes of identification, the tine type is generally called a grapple and the scoop type called a bucket. Each type of scoop has certain advantages and disadvantages.

Closed Scoop Type. The closed scoop type is the oldest in years of service and is basically the same as the unit used in standard rehandling buckets. It has a heavy lip at its leading edge to absorb the blows caused by dropping the bucket on the material and to increase the wear life of the scoop edge. This lip also aids in maintaining scoop alignment. In handling refuse, it is generally necessary to augment the penetrating ability of the lip by adding teeth. Usually seven teeth, four on one scoop and three on the other, are adequate. These teeth should extend approximately eight inches beyond the leading edge of the lip. These teeth are normally bolted to the lip so that they can be replaced as they wear and/or bend due to striking the walls of the concrete pits. The teeth are normally made of alloy steels for high strength.

Also, due to this abuse, it is common practice for the bucket manufacturers to provide corner bumper pads, scoop corner reinforcing, and protection collars on pins. These items should definitely be specified when purchasing an incinerator bucket. The main disadvantage of a scoop type incinerator bucket is that the side walls of the scoops restrict the flow of the refuse into the bucket and thus often limit the capacity of this style of bucket. This style of scoop is better adapted to cleaning up the pits than the tine type, although the teeth normally added to the bucket do present some problem in this operation.

Tine Type. The tine type or grapple was developed specifically for incinerator work. Essentially, these grapples are clamshell buckets with the scoop side plates and back plates stopped approximately half way between the corner brackets and the normal lip mating line. Projecting from these reduced scoops are long teeth called tines, either three or four on a side, directly opposite one another. The number of tines is a function of the width of the grapple. The tines should be spaced approximately one and one-half feet to two feet center to center and project approximately one and
...onc-quarter foot to two feet beyond the leading edge of the lips. These dimensions will vary according to the physical size of the grapple.

The following items are a must in specifications for incinerator grapples:

1) The tines must be constructed of high strength steel, definitely of the 100,000 pound tensile strength class.

2) Bolting is generally the most satisfactory method of joining the tines to the scoops, but it must be augmented by shock absorbing members attached to either the tine or the scoop, or both.

3) The tines need not meet at the centerline when the grapple is closed, but can be cut back three or four inches from the centerline.

4) A high strength steel lip running completely around the scoop's leading edge is necessary for proper mounting of the tines.

5) Scoop corner reinforcing and corner bumper pads are essential.

6) Protection for all scoop pins is required.

7) Three or four parts of reeving are necessary for lever arm buckets, up to five parts for non-lever arm buckets.

A properly constructed grapple will absorb as much punishment as a bucket in incinerator service and will yield an average of 40 per cent more capacity than an equally rated bucket. This is the tremendous advantage of the incinerator grapple over the incinerator bucket.

The main disadvantages of the grapple are its higher cost due to the high class of steels required in its construction and its heavier weight than the corresponding sized bucket due to the increased thickness and depth of the grapple's vulnerable members required to absorb the abuse that they are exposed to in this application.

The grapple also is a poor cleanup tool. However, it can be modified for this service by the attachment to the tines of a pair of removable scoops during the cleanup operation. These scoops are available at extra cost on all size grapples from some manufacturers. For the more economy minded, an old mattress clutched between the tines of a closed grapple makes a good broom for sweeping the pits and greatly aids in pit cleanup.

**Analysis of Bucket Components**

The bucket or grapple scoop, as a basic material handling tool, is a real veteran in the incinerator plant field. Like any tool, its ability to produce the best results, can only be achieved by the proper selection of all the components going into its makeup. Only careful analysis of all of the parts will enable one to choose the correct tool for incinerator service.

**Cable Arrangement.** Let us first consider the cable arrangement as it enters the head of the bucket. The most commonly used cable arrangement for incinerator work is the three line cable plan, utilizing one cable for closing the bucket and two cables attached to the head of the bucket for holding the bucket. This three-line arrangement is an adaptation of a normal two-line bucket wherein one line is used for closing the bucket and the other line is attached to the head block for holding the bucket. In the two-line cable arrangement, the bucket tends to spin about the hold line whenever the close line is slack due to the hold cable trying to untwist itself. A pair of hold lines dead ending on a steel bar, called an equalizer, is substituted in the three-line arrangement for the single hold line of the two-line bucket, thereby improving the stability of the bucket and keeping it from spinning. This cable arrangement is both simple and effective. Other types of cable arrangements are single line and four-line styles. Single line and four line buckets are both expensive types. The single line bucket is costly to build due to the internal mechanism required to enable it to open, close, and hoist from a single overhead cable. The single line bucket is the most unstable bucket with respect to spinning and requires the use of a tag line for maintaining its equilibrium. It is possible to direct reeve a single line bucket from a single drum crane. This attempt to limit spin is, at best, a make-shift arrangement and is not equal to the three-line arrangement. Further, the single line buckets are slow in operating speed and, therefore, are not a good choice for incinerator service as they greatly limit the capacity of the plant.

Another class of expensive buckets are the so-called four-line or four rope buckets. These are generally used in industrial plants such as steel mills and cement mills. The reason such buckets are used is the large loads that they are capable of handling. Buckets in this category are capable of lifting up to 22 tons of iron ore or coal in a single grab. Such huge loads require enormous buckets, and gross loads of as high as 50,000 pounds are not unknown. To carry such loads, a four-line bucket must be used in order to keep the cable sizes reasonable. Individual cable size of 1-1/4 inch diameter is common and even then cable safety factors range around 3 to 1 as opposed to 6 to 8 to 1 often used in incinerator installations.

It is possible that future incinerator plants may be built to handle such large loads and thus create the need for four-line incinerator buckets. However, at the present time, the need for this type of bucket does not exist.

**The Head of the Bucket.** The head of the bucket consists of the head block, head sheaves, guide rollers...
and/or guide sheaves and related pins. The necessary attaching members for the hold lines may also be considered part of the bend. In general, incinerator buckets have small sheaves in both the head and the lower blocks due to the rather limited headroom available in incinerator plants. This is not necessarily an undesirable feature however, since cable wear is a direct function of the smallest diameter element over which the cables bend. This is, in all cases, the guide rollers. Thus, the diameter of the guide roller should be a main concern to the bucket user. While it is true that, if the bucket remains vertical at all times, there is little or no bending of the cable over the rollers, unfortunately, most crane operators permit the bucket to fall over on its side into the refuse. This causes the closing line cable to bend sharply over the rollers. Here is a point wherein good crane operation can greatly increase cable life.

The member or bar to which the two hold lines are attached is called the equalizer. One type of equalizer is mounted above the head block and, as such, adds to the overall height of the bucket. There are two styles of this type of equalizer, one in which the bar runs parallel to the opening direction of the bucket, and a second in which the bar runs perpendicular to the opening direction of the bucket. A second type of equalizer, which consists of two parallel bars straddling the head of the bucket, is also available to aid in reducing headroom where such headroom is at a premium. Whether a parallel or perpendicular style of equalizer is used is dependent upon the crane design and is a point to consider when buying a new crane.

The Corner Bars. The corner bars are those structural members which attach the head of the bucket to the scoops. These members may be solid steel bars or built-up sections. The method in which they attach to the head block is critical. A simple arrangement is one in which a single pin connects all four of the corner bars and also serves as the head sheave pin. In this arrangement, all closing forces exerted on the head pin are transmitted directly to the corner bars, thus preventing any bending moment from these forces from being exerted on the bars.

Other arrangements of corner bar to head block connections create bending forces which require either heavier corner bars and/or additional bracing. For a given size of bucket, such additional dead weight tends to increase the size and horsepower requirements of the crane.

The Lower Block. The lower block is attached to the scoops in various arrangements. These arrangements have been described as either lever arm buckets or multiple reeved buckets although, in fact, all clamshell buckets are multiple rope reeved. It would be more correct to any lever arm type buckets or non-lever arm type buckets. In the non-lever arm type, the closing force is directly proportional to the number of parts of reeving. In the lever arm type buckets, the closing force is further increased by the length of the lever arm. Thus, the lever arm type bucket will always have the greatest closing power, assuming it is reeved the same number of parts of line as the other type of bucket.

Bucket Size and Weight

After having determined the desired cable arrangement, type of bucket, and general construction features including type of scoops, the next consideration must be that of size and weight of bucket. In existing installations, the gross load of the crane is known and it is simple to determine the correct bucket capacity. In figuring weight of material for refuse, densities in the range of 15 to 20 lb/cu ft are commonly used when computing refuse weights. In plants handling segregated material that is primarily garbage, a weight of 30 lb/cu ft may be more representative. If it is desired to try a grapple in an existing plant in place of a bucket, but the additional weight of the grapple may exceed the capacity of the crane motors, a grapple a half-yard size smaller than the bucket may be a good selection. Its dead weight will generally be less than the larger bucket and it will out perform the larger sized bucket.

For example, a Blaw-Knox 2-1/2 cubic yard incinerator bucket weighs 5355 pounds including teeth. A Blaw-Knox 2 cubic yard incinerator grapple weighs 5000 pounds. However, the grapple which is nominally rated at 2 cubic yards, will actually average 2.8 cubic yards of refuse per grab. Thus the lighter weight bucket yields bigger payloads and therefore increased plant capacity. This last conclusion naturally raises the question that, if this statement is true, why aren’t the grapples rated corresponding to their actual capacity? The reason they are not so rated is due to the difficulty of developing a standard method of calculating grapple capacities. The refuse is not gathered neatly into the grapple and no two loads are ever identical. Therefore, grapples are rated in somewhat the same manner as buckets, with length and width the primary determining factors. Thus, a two-yard grapple will have approximately the same length and width as a two yard bucket but its refuse handling capability is quite different.

For new installations, bucket size must be related to crane selection. The crane manufacturers are prepared to assist in determining the proper size bucket to use with their particular crane for the plant capacity being considered.
When considering bucket weights, it may be stated in general that there must be a direct proportion between the bucket weight and the weight of the material being handled. Thus heavy materials require a heavy bucket to penetrate and dig and, correspondingly, light weight materials require only a light weight bucket. It will be found that all buckets offered for incinerator plant service fall into the latter classification. However, the bucket should not be extremely light weight as it will then not take the abuse caused by blows against the concrete pit walls and floor.

Material Specifications

In addition to the factors to consider related to the components of incinerator buckets outlined above, the materials used in the bucket construction should also be considered when making the selection. In general, most incinerator buckets are constructed of mild carbon steel whether the parts be plate or castings. This may also include the lips for a scoop type bucket. As mentioned previously, this steel is not adequate for all structural members of tine type grapples. Thus, the proper material should be specified for critical members.

An exceedingly good, high strength, low alloy steel for bucket construction is United States Steel Corporation brand “T-1”. Now available in type “A” at a slightly lower cost than regular grade, but still retaining all its excellent physical characteristics, this steel is readily weldable without requiring pre-heat by simply using a low hydrogen rod of the proper rod metal strength. This steel is an excellent choice for scoop bucket lips to absorb the punishment of hitting the pit walls, and is also strong enough to absorb the bending forces created by loads on the projecting teeth.

The items most commonly requiring replacement in an incinerator bucket are the pins and bushings. As standard equipment, these items are furnished in cold rolled steel, e.g., C-1020, for pins, and cast iron or ordinary steel for bushings. While these materials are adequate for contractor’s buckets that are used a maximum of 12 hours a day for roughly six months out of the year, their wear life is far too short in an incinerator plant running 24 hours a day, six or seven days a week. Here is a very important place to specify better materials, such as alloy steels for pins and manganese-bronze for bushings. Hadfield manganese-steel makes a terrifically long lasting bushing, and will normally cause the alloy steel pins to wear out first. However, it is generally considered to be easier to replace a pin than a bushing, and in industrial applications, 12 to 14 per cent manganese-steel alloy is a common bushing material.

Normally incinerator bucket closing line sheaves are bronze bushed. An option of ball or roller bearings is offered at a slightly higher price. One manufacturer offers bronze bushed head sheaves and ball bearings in the lower block sheaves. This is another detail that should be carefully studied when developing the bucket specifications.

If, after carefully investigating the requirements of a particular application, the need for the higher class of materials is not apparent, they should not be specified. Accept the manufacturer’s standards. Their standards are the result of many year’s experience and will usually give satisfactory service for a considerable period of time. Later on, if it is decided that some particular component should be up-graded due to the experiences at a particular installation, the higher quality component can be specified on the next bucket or in the replacement part order.

Plant Design Considerations

The amount of headroom provided for the bucket over the furnace hoppers is an important consideration during the design of a new installation. A minimum of two to three feet from top of hopper to the bottom of the open bucket is required to allow for refuse hanging below the scoops or tines. The open height of the bucket should also be considered. Finally, sufficient headroom must be allowed for attaching the holding cables to the equalizer. The amount of headroom required for the attaching of these cables to the equalizer depends on whether the standing end of the cable is clamped to the running part or whether sockets and wedges are used.

Sometimes in an attempt to reduce plant costs, the lowest headroom bucket available on the market will be specified. However, buckets designed to achieve unusually low headroom often have peculiarities in their construction and very often this type of bucket does not stand up very well in every day high production work. Then, if it is desired to replace this bucket to obtain a more satisfactory tool, it is discovered that no other bucket can be fitted into the restricted headroom plant. Thus, the plant would have to continue using the inferior bucket, or the roof would have to be raised, an extremely expensive operation.

It will do no good to specify a high quality bucket for a new incinerator plant and then find that there is not sufficient headroom available. These two conditions go hand in hand. Sufficient headroom for the high quality bucket should be included in the initial plant design. Additional headroom in this area is very costly if it requires raising the roof of the plant after it is built.
Conclusion

This then is the story of the incinerator bucket. Careful selection in its purchase, proper use in its operation and a good program of preventative maintenance will yield many years of satisfactory service with a minimum of repairs. Remember, this key tool is the only link between the incoming material and the furnaces, and as such cannot be treated lightly. It is definitely one item whose selection must not be relegated to a low bidder category. The ability of the entire incinerator plant is dependent upon its performance. Insist on high standards in purchasing this tool and your dividend will be a highly productive plant.