SPECIAL FACTORS INVOLVED IN SPECIFYING INCINERATOR CRANES

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ABSTRACT

America’s population explosion has been accompanied by many related explosions — some good, some bad — all of which must be resolved by efficient municipal planning and action.

A particularly significant after-effect of growth in urban population is something that might be labeled “the refuse explosion.” Americans today are producing municipal refuse at a rate of more than 4.5 pounds per capita per day. The ultimate consumer and disposer of this mass production is the municipal incinerator plant.

Modern technology has brought great sophistication to the design of these plants, creating high-capacity processing systems that are well able to meet the burgeoning demand. Among the most important factors in this process is material handling. Among the most important components are the overhead bucket cranes used to transport refuse from the storage bins through rehandling and mixing, then on to the incinerator furnace hoppers. Here the material-handling duty cycle is always continuous, always strenuous. The purpose of this discussion is to relate the nature of the duty cycle to the crane specifications, to answer the question, “what makes a good incinerator-crane specification?”

CLASSES OF CRANES

Now, let’s define the overhead crane. Beyond its function as a hoist that raises and lowers materials, it moves things in all directions. The welded double-girder type crane, the subject of this discussion, comes in five categories or classes.

Class “A” is for standby or power-house cranes — used in servicing generating equipment — with capacities ranging up to 600 tons. Speeds are slow, and use is only occasional.

Class “B” covers the light-duty category — the kind of crane found in many machine shops and warehousing operations, requiring moderate speeds and infrequent lifts — no more than five to ten full-load lifts per hour.

Class “C” defines the moderate-duty crane — most often specified for the lighter foundry and mill operations that call for average speeds and intermediate lifts. The maximum demand for full load lifts is ten to twelve per hour.

Class “D” covers the heavy-duty or constant crane, generally specified for fast, frequent operation, designed to make from twenty to forty full load lifts per hour.

Class “E” is for severe duty. This is the class most often specified for incinerator plants. Why? Because job requirements generally call for extremely fast speeds, very high frequency of lifts per hour in a hostile atmosphere, and operation almost around the clock. For example, where travel speeds of 60 to 80 feet per minute may be good enough for an industrial crane, refuse-handling may demand speeds from 300 to 450 feet per minute, along with tremendously quick changes from acceleration to deceleration. Daily lifting requirements may involve 45,000 or more revolutions of the hoist drum.

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Figuring a gear ratio of twenty to one, this can multiply to well over 900,000 revolutions at the motor pinion. You can imagine what that means to the bearings. Their life should be qualified on at least a ten-year operating basis (what is referred to as minimum 40,000 hours B-10). Shafts and axles assume correspondingly larger diameters to meet severe demands. With the extreme shock and reversals involved, impact loads of fifty percent and over are not at all unusual.

**FRAME RATING**

The application of the five basic crane classifications is vital to a good specification. In practice, these classifications allow the crane builder to arrive at a number of frame capacity ratings. An effective incinerator crane must provide bearings, gearing, shafts and structures able to withstand the rigors of the most severe duty. The result of proper selection is dependability, long service life, and low maintenance cost.

What goes into selection of the right frame rating to make sure the resulting installation will deliver optimum performance today and in the future? The first step is obvious. We need to know the planned capacity of the incinerator plant i.e. the tons of refuse to be burned and stored, the types and weights of the material and the peak load hours.

Step two is to prepare a layout of the area over which the overhead bucket crane will preside. This layout must clearly delineate the size and location of all bins, furnaces and hoppers. It must include all elevation dimensions that effect the heights to which the bucket must be raised before the crane's bridge or trolley motions can take place.

Preparation of a comprehensive material flow chart is the third step. Every conceivable move to be made by the crane in the refuse handling process must be outlined: the amount of refuse to be deposited in the hoppers each hour to satisfy the burning rates of the plant's furnaces, the amount of refuse that must be mixed in the pit to compensate for weather conditions and to insure proper combustion of the various types of refuse received, and the amount of refuse to be rehandled in peak dumping periods (a procedure sometimes requiring one-half of crane cycle time) to assure continuous processing of incoming loads during the early shifts. And, of course, the distances involved in all hoist, bridge and trolley functions must be carefully plotted.

The fourth step calls for analysis and coordination of all the data gathered in the preceding steps. It involves a comprehensive definition of the amount and weight of material that must be moved in a specified time period during each duty cycle. This cycle-time-scheduling is among the most important factors in determination of proper crane duty requirements.

The information resulting from the four steps covered gives the crane builder a clear picture regarding optimum crane capacity, speeds required for all handling functions, and pattern sizes appropriate to the maximum service factor. It supplies the purchaser with a measure of assurance that the crane he gets will live up to expectations. The ramifications involved make each of these initial four steps subject to the attention of experts, professional municipal engineers and consultants who are well versed in the vagaries of incinerator plant design and mass material handling.

Once we have the information required to select the appropriate frame size for an effective incinerator crane, what else needs to be considered in making a good specification?

There are many things to look into, many features to consider, that will implement efficiency as well as operating safety and economy. These features are to be found in the structural, mechanical, and electrical engineering aspects of crane engineering. They are also to be measured in terms of the crane builder's responsibility, his ability to weld all these component facets compatibly into a machine that delivers the dependability the incinerator plant investment requires.

**CRANE FEATURES**

Now let's review those crane features, starting with structure. Even though the capacity rating of an incinerator crane is normally light compared to industrial cranes, its work usually involves far higher ratios of dead weight to live load capacity. A four-ton, 40-foot span heavy-duty incinerator crane will weigh up to 75,000 pounds. A Class "C" industrial crane, with five times as much capacity and double the span, weighs no more. All components of the incinerator crane must be designed and built to withstand heavy shock and impact. The welded box girders of the crane bridge must be of ample depth and width to resist extreme torsional stresses and deflection. The bridge end trucks should be factory aligned to assure squareness, to guarantee against impairment of wheel and bearing life. They should be equipped with master car builder (MCB) mountings for wheels and bearings to provide maximum life under severe-duty conditions, to implement ease of maintenance. Appropriate wheel and runway rail sizes must be carefully selected.
Flangeless bridge wheels with side-guide rollers are a recent development designed to reduce runway and wheel-flange wear. Located ahead of the bridge wheels, the side-guide rollers operate against the side of the rail head at right angles to the wheels. They exert rolling friction in place of the scrubbing action and high-friction effect of the flange type wheel. Because loading is radial, thrust-loading of wheel bearings is eliminated. With wheel loads equally distributed, the bearings naturally last far longer.

The structural aspects of a good crane specification are tightly bound to structural considerations in the incinerator plant itself. The design should provide for adequate parking areas in multiple crane plants so that any one crane can service all hoppers and pit. Most importantly, it should provide for ample clearances in all directions. The crane needs breathing room in order to deliver up to its planned duty cycle. The question of clearances is a subject worthy of detailed discussion by specifying engineers and the technical representatives of the manufacturers who bid on the installation.

The next area of features involves the mechanical aspects of the incinerator crane, and the bearing these have on a good specification.

Deep-carburizing of wearing parts is an important consideration. This hardening process imparts superior toughness to alloy-steel wheels and gears. The work to be performed by an incinerator crane makes hardening procedures a necessity. Along with hardness, resistance to shock-loading and reversals must be considered in the specification. All drums, for example, should be of steel, grooved and hardened to withstand the fumes and ash content of the atmosphere in an incinerator plant. As mentioned earlier, the selection of quality bearings is imperative. This also applies to shafts and axle materials. It is important, too, that the specification includes provision for ease of maintenance of all these items.

Depending on the type of refuse involved, the incinerator crane will be equipped with either a grab bucket or a grapple. The latter, of course, has the ability to handle more refuse, while having the same yardage capacity as its bucket counterpart. Among the factors to be considered here is the direction of the bucket or grapple opening and the relationship of the holding and closing drums. The prime consideration in regard to direction of opening is efficiency and ease in obtaining full loads from the refuse pile. In most cases, the ideal bucket opening direction is parallel to the long axis at the storage bins. On the relationship of the drums, it is considered good practice to have them located in the same direction as the lay of the bucket on the refuse pile. This insures that the cable will work in the grooves, not against the grooves.

Provision for adequate lubrication is obviously an important factor in the mechanical specification. The kind of service to which an incinerator crane is subject calls for use of centralized lubricating systems. A separate one-pump system for the bridge and another for the trolley are a good answer. When it comes to gearcases, designs that provide for splash lubrication of the bearings inside are recommended.

Specifying the right cab makes a big difference in extending operating efficiency. Because of the variety in design of incinerator plants, with different vision problems existing for each, the crane builder must provide variety in cab design. This includes cabs that go all the way, protecting the operator against heat, fly-ash and fumes in a fully air-conditioned environment. Make no mistake. The comfort has a purpose and that purpose involves both the safety and the productivity of the incinerator crane operation. The specifications for many installations call for remote control as an alternative to cab control. In such installations, the operator is in charge of all functions, working in a pulpit from which he maintains visual contact with the business end of the operation.

**ELECTRICAL**

Now for a highlight outline of the electrical design features that could make the difference between success or failure in specifying an incinerator crane. Breakdown of electrical components is the major single cause of shutdowns and costly down time. The demands of incinerator crane duty are unique. Dependability is vital. Standard electrical components adapted for cranes just don't cut the buck. This is why the controls, motors and other electrical components should be specifically designed for crane service.

First, consider motors. The proper selection of these is basic to a good specification. The starts, stops and reversals involved in the work add up to heat, heat exceeding the capacities of standard motors, requiring motors having from 120-minute 75 degree centigrade to continuous ratings, with Class F insulation (depending on the duty cycle).
Whatever type of motor is specified, it must be designed to meet the exceptional demands of incinerator crane service. It is important to remember that, unlike the motors on hook-service cranes, incinerator crane motors always operate under load. A typical 2-yard grapple weighs 5,000 pounds, with the refuse itself weighing about 1,000 pounds. It is obvious that the hoist motors are always under exceedingly heavy load.

Now the question of incinerator crane control. One type is full magnetic variable speed control with counter-torque on the holding and closing motions and with reversing-plugging on bridge and trolley motions. In specifying this kind of control, it is wise to insist on heavy-duty mill type contactors and to incorporate control schemes that are especially responsive to both speed and load. In recent years, many incinerator-crane specifiers have found a new measure of dependability and precision in a-c static stepless control with electric load brake for holding and closing motions. This type of control virtually eliminates contactor maintenance, since there is only one reversing contactor per motion. The static switching devices are potted in an epoxy resin compound, eliminating the need for additional contactors. And there's no need for contact-tip maintenance or replacement of controllers, because there are no contacts in the induction master controller. The electric load brake accomplishes most of the hoist braking. Thus, brake lining wear is substantially reduced. Furthermore, you can expect greatly increased motor insulation life, since deceleration by the plugging of a motor is also accomplished with the electric load brake.

The precision features of a-c static stepless crane control include an infinite number of speed steps available within the limits of the speed range as well as positive direction of movement. With a joystick controller, combining two motions in one master lever, operators realize faster cycle times and smoother, easier operation. While joystick master levers lend themselves to use with full-magnetic control, their advantages are most apparent in conjunction with a-c static stepless crane control. A further development along these lines involves controllers built into the armchair. Solid-state miniaturization puts the crane controllers in the arms of the chair itself enabling the operator to control all crane functions with his finger tips, while sitting down on the job. This serves to create a dramatic reduction of the fatigue factor once reckoned as a 20 percent burden on duty cycle productivity, to say nothing of stepped up operating safety.

Until recently, good incinerator crane specifications provided for double collector shoes on rigid steel or aluminum angle bridge-span conductor systems. Despite admitted faults, including time required to maintain collector shoe conductor contact to prevent single-phasing and open circuits, this was the best available approach to handling bridge-span circuitry. This is no longer true. New festooned conductor-messenger systems give the specifier an important trouble-reducing alternative. Insulated cables are gathered together, with coils looped and attached to individual monorail trolleys, designed to follow the crane trolley all across the span. Such a system provides a constant potential and continuity of circuitry with minimal maintenance needs: no collector shoes to adjust or maintain, no danger of contact with exposed span conductors.

The electrical specifications for an effective incinerator crane should pay infinite attention to detail. For example, the nature of the work calls for control enclosures that provide positive protection against dirt and dust, while being easily accessible for inspection. The specs must provide for a full complement of overload, undervoltage and short-circuit protective devices such as knife switches for control and power circuits as well as disconnect switches to meet every safety and maintenance requirement.

While the purpose of this discussion is to present the highlights rather than technical details, it wouldn't be complete, even as an outline, without touching on the following:

1) Provision for spare parts. In view of the duty cycle encountered by an incinerator crane, it is exceedingly important that the specifications call for a basic inventory of spare parts. These would range from expendable wear items (such as brake shoes and linings) to basic components (such as motors) which are vital to the continuity of operation.

2) Provision for instruction. The crane specification should commit the builder to provide the purchaser with a planned program of training in two areas: operation of the crane and routine maintenance of the crane.

3) Provision for call-back service as a basic responsibility of the crane builder. The standard should be four call-backs a year; once every three months during the first year, whether needed or not, to insure proper crane operation as specified.

Incinerator crane specifications would be incomplete without a brief look at what might be included in the future. We have touched briefly on advance-design items already available, such as armchair control and flangeless bridge wheels. It is safe to predict that these will soon be standard on all incinerator cranes.
The incinerator cranes of the future will be built to include refinements that will assure more efficient and reliable operation, not only of the crane, but of the entire incinerator plant. Already the ability to accurately weigh each refuse charge to the furnace hopper is within our grasp. Also, automation of incinerator cranes to reduce the cost of operation is fast approaching reality. The necessary control devices are already available and only final development and testing of the hardware needed to sense depths stands between us and the advent of another new era in mass handling of refuse.

As mentioned before and as evidenced by this presentation, a good crane specification deserves the attention of experts. It's a job for engineers and consultants, a job that should start at the inception of an incinerator plant. The job isn't over with the writing of the specs. It calls for personal, careful analysis of each manufacturer's proposal, not only in terms of the specification, but also in terms of the maker's capabilities. It's not something to turn over to a general contractor who has the many other problems of plant construction on his mind. Engineers and consultants are best qualified to examine each bid and measure all critical factors such as 1) evaluation of each builder's facilities. Is he capable of producing a precision product? 2) evaluation of responsibility. To what extent is the builder responsible for all the structural, mechanical and electrical components? 3) evaluation of the builder's ability to service the equipment in his bid. Will he follow through, or will he delegate service to other manufacturers who supplied components? 4) evaluation of the builder's ability to supply parts. Can he get you the replacement your crane needs promptly, or must he depend on delivery from a third-party supplier?

CONCLUDING REMARKS

This has been no more than outline of the tangibles and intangibles involved in preparing a good specification for an incinerator crane. It's a complicated task that deserves the attention of the best technical brains that can be engaged. An inadequate crane can haunt you for many years, but the right crane is an investment that keeps paying off for forty years or more.

Given the facilities, the experienced personnel and, most important, the desire, any crane builder can meet the varying ramifications of a good specification. The key word for all of us involved in manufacturing cranes is "desire". For the purchaser, the key is to utilize this desire in the best possible manner, to use the best technical minds at his disposal, to deal specifically and directly with the companies whose products will implement all of the objectives of a good crane specification.