11.2.3 Types of Tracking

Point-focus optics generally require that the concentrator track about two axes so that it is always pointed at the sun, and the focused light falls on the cell. From a mechanical standpoint, two-axis tracking is more complex than one-axis tracking; however, point-focus systems are also capable of higher concentration ratio and hence lower cell cost. Line-focus reflective troughs need only track along one axis such that the image falls along the focus line. Linear Fresnel concentrators suffer severe optical aberrations when the sun is not perpendicular to the lens' translation axis. (Basically the focal length decreases as the sun's angle moves from normal to the lens.) This generally limits linear Fresnel systems to two-axis tracking. Modest geometric concentration ratios of around 10 are possible, however, if the lens tracks on a polar axis, which limits the sun's angle off normal to 23° maximum [4].

There are three common types of two-axis trackers as shown in Figure 11.3. The pedestal form uses a central pedestal supporting a flat tracking array structure. Tracking is usually effected by a gearbox, which tracks the array along a vertical axis (the azimuth rotation) and along a horizontal axis (the elevation rotation). An advantage of this configuration is the simplicity of installation (basically drilling a single hole, inserting the pedestal into the hole, back-filling with concrete, and placing the array and gear drive on the pedestal). A disadvantage is that wind loads are translated to the central gear drive in the form of very large torque, necessitating large capacity gears. Another form of two-axis tracking is the roll-tilt structure of Figure 11.3(b). Here wind loads on drive components are considerably reduced; however, there are now more rotating bearings and linkages required. Obtaining the required stiffness along the roll axis can necessitate a rather large-section horizontal support member. The structure also requires multiple foundations that must be aligned, complicating installation. The roll axis is most usually placed in a north–south direction, as this minimizes shadowing by adjacent modules along the roll axis. Another roll-tilt configuration uses a box frame with the Fresnel modules pivoted between the upper and the lower frame. This is shown in Figure 11.3(c). The final common configuration is the turntable of Figure 11.3(d). This structure provides for the lowest profile and lowest wind loading, and can use rather small drive components and support members. On the other hand, it presents the most complex installation scenario.

One-axis trackers are generally configured with either a horizontal axis of rotation or a polar axis of rotation as shown in Figure 11.4. A horizontal axis provides for lower profile and larger area per tracking structure, as compared to the polar-axis approach. Horizontal-axis trackers usually use reflective troughs. It can be seen that the sun can be at a fairly large angle to the array, especially in the winter with a north–south axis or early and late in the day with an east–west axis. This causes the image to move a distance down the focus axis and can result in significant end losses and image broadening. The polar-axis configuration, on the other hand, gives higher intercepted annual energy and limits the incoming sun angle to a maximum of 23° from the plane of the concentrator. The simplicity and low profile of the horizontal-axis configuration makes it the more common choice over the polar-axis approach.

11.2.4 Static Concentrators

In principle, it is possible to provide some concentration without any tracking at all. The reasons for this are severalfold. First, the sun appears in only a restricted portion of the