A dual-path parallel superheater includes a drum for delivering steam, a steam receiving apparatus opposite the drum for receiving steam, a first surface and a second which receive steam from the drum to provide first and second paths for superheating the steam before delivering it to the steam receiving apparatus. There are also spray atomizers along the first and second paths.
DUAL PATH PARALLEL SUPERHEATER
FIELD AND BACKGROUND OF INVENTION
[0001] The present invention relates generally to methods and devices for effectively increasing the delivery of steam in a controlled and efficient manner.

[0002] It is commonly required that temperature and/or steam flow (capacity) of an existing boiler be increased. Pressure drop across the superheater increases as the steam capacity increases. High pressure drop is often the limiting factor for a capacity increase. As a result, the complete superheater regularly needs to be replaced to provide a lower pressure drop.

[0003] In a typical scenario, an operator requires that steam flow be increased (e.g., 543.4 kphl). Standard practice is to arrange the superheater such that there is only one path by which steam can become superheated. In order to superheat at the increased rate of steam, additional surface is added. FIG. 1 hereof shows a typical prior art arrangement 10 for a single-path series superheater, in a new surface 12 is added to an existing surface 14 to process the increased capacity. There is a provided a drum 16 for delivering steam to surfaces 12 and 14 and a turbine 18 for ultimately receiving steam from surfaces 12 and 14.

[0004] Table 1, below, predicted steam temperatures and pressures at the locations as defined by FIG. 1.

<table>
<thead>
<tr>
<th>Location</th>
<th>Pressure (psig)</th>
<th>Temp (deg F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1403</td>
<td>589</td>
</tr>
<tr>
<td>B</td>
<td>1384</td>
<td>744</td>
</tr>
<tr>
<td>C</td>
<td>1346</td>
<td>697</td>
</tr>
<tr>
<td>D</td>
<td>1322</td>
<td>842</td>
</tr>
<tr>
<td>E</td>
<td>1275</td>
<td>840</td>
</tr>
<tr>
<td>F</td>
<td>1236</td>
<td>900</td>
</tr>
</tbody>
</table>

[0005] Desired outlet pressure is 1300 psig and desired outlet temperature is 900° F.

[0006] To control steam temperature there are spray attemperators at two interstage locations, the first between locations B and C and the second between positions D and E. The prior art arrangement is predicted to make full steam temperature with a total of 49° F. of spray attemperation. However, the arrangement does not achieve the target outlet pressure of 1300 psig. The best achievable outlet pressure is only 1236 psig. The traditional remedy for this is to increase the number of parallel steam flow paths in the existing surface. This requires the replacement of all the existing superheater tubes, superheater headers, roof seals, etc. and often requires that sootblower cavities be relocated.

[0007] Thus, there is a need for increased steaming rate without the need for replacement of the existing superheater.

SUMMARY OF INVENTION

[0008] The present invention is drawn to a dual-path parallel superheater includes a drum for delivering steam, a steam receiving apparatus opposite the drum for receiving steam, a first surface and a second which receive steam from the drum to provide first and second paths for superheating the steam before delivering it to the steam receiving apparatus. There are also spray attemperators along the first and second paths. [0009] The present invention is a system and method in which steam is divided into two paths at the drum outlet. One path is defined by existing superheater surface and the other by new surface overheating the furnace. Each path is independently controlled with spray attemperation and independently achieves full steam temperature. The streams are recombined to a single path at the superheater outlet. The present dual-path parallel superheater ("DPSS") allows for an increased steaming rate without requiring the replacement of the existing superheater.

[0010] The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming part of this disclosure. For a better understanding of the present invention, and the operating advantages attained by its use, reference is made to the accompanying drawings and descriptive matter, forming a part of this disclosure, in which a preferred embodiment of the invention is illustrated.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] In the accompanying drawings, forming a part of this specification, and in which like reference numbers are used to refer to the same or functionally similar elements:

[0012] FIG. 1 is a schematic view of a prior art single path series superheater; and

[0013] FIG. 2 is a schematic view of the present dual path parallel superheater.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] With reference to the FIG. 2 the dual path parallel superheater ("DPSS") according to the present invention is shown, the superheater arranged such that there are two parallel paths by which steam becomes superheated. FIG. 2 shows the DPSS arrangement, in which a new surface 22 is added to the original surface 24 to process increased capacity. As in the prior art structure, there is a provided a drum 30 for delivering steam to surfaces 22 and 24 and a steam receiving apparatus 32 such as a turbine for ultimately receiving steam from surfaces 22 and 24.

[0015] Table 2 below shows predicted steam temperatures and pressures at the locations A1-A4 and B1-B4, defined in FIG. 2.

<table>
<thead>
<tr>
<th>Location</th>
<th>Pressure (psig)</th>
<th>Temp (deg F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>1378</td>
<td>586</td>
</tr>
<tr>
<td>A2</td>
<td>1344</td>
<td>706</td>
</tr>
<tr>
<td>A3</td>
<td>1324</td>
<td>665</td>
</tr>
<tr>
<td>A4</td>
<td>1300</td>
<td>900</td>
</tr>
</tbody>
</table>

[0016] Desired outlet pressure is 1300 psig and desired outlet temperature is 900° F.
FIG. 2 reflects two paths: Path A, marked by locations A1-A4, and Path B, marked by locations B1-B4. To control steam temperature, each path has a spray attenuator at oneinterstage location.

As shown in FIG. 2, Path A, including locations A1-A4, is arranged in a side by side orientation in order to utilize interstage spray 26 while only requiring that one new bank be installed. The interstage spray attenuator 26 is located between positions A2 and A3. The attenuator 26 controls steam temperature and combats high metal temperatures inherent to low steam flow.

The tubes in the Path A bank may be made of a steel compound such as SA213-T22, a plurality of rows of stainless steel tubes may be employed in the outlet legs. Additionally, the side by side design of the present invention maximizes the amount of new heating surface required because hot steam is reintroduced to the front of the furnace, where the flue gas is hottest.

Path B, including locations B1-B4, reuses the unit’s existing superheater surface and existing interstage spray 28 located between positions B2 and B3. The interstage spray 28 controls steam temperature and combats high metal temperatures inherent to low steam flow. Similar to Path A, metals in the Path B banks may be made of materials well-known to those of skill in the art. The exception is the outlet rows of the Path B primary superheater. These rows generally require replacement with stainless steel tubes.

Both Path A and Path B achieve full steam temperature independently. Path A has 41° F. of spray margin and Path B has a 61° F. of spray margin. After being controlled to the same temperature, steam from Path A and Path B recombine to form a single outlet.

The parallel paths A and B are designed for the same pressure drop. This can be accomplished initially by underdrilling headers in the new surface or installing orificed Dutchman in the existing surface. Underdrilling headers and the installation of orificed Dutchmen are techniques known to those of skill in the art. However, as the unit becomes dirty, and spray flow changes, the pressure loss in each line may change. As a means of control, a trim valve may be installed in at least one of the lines. With the ability to dynamically adjust pressure drop, steam flow is enabled to remain as designed in each path. Thereby, steam temperature and pressure can also be maintained as designed.

The present invention offers numerous advantages. The present invention is for industrial boilers undergoing capacity increases. When steam rate increases the amount of pressure drop between the drum and superheater outlet increases. If the newly-desired steaming rate is high enough, a new superheater with additional flow paths is required to maintain outlet pressure. A new surface is required regardless of the existing superheater condition. As a result, operators are often forced to scrap tubes before they reach end-of-life, or abandon their projects all together due to high project costs. The present DPPS allows for increased steam flow without replacing existing surface.

Operators continuously strive to get as much as possible from existing equipment before investing in replacement. This is especially true when the existing equipment is in good operating condition. The present invention provides cost savings to operators through the re-use of the existing surface. The present invention allows satisfaction of an increased steam demand at a lower cost than traditional solutions. The present invention may be applied to many different arrangements, offering flexibility in its application.

The present DPPS arrangement may be applied to several boiler types, including but not limited to, process recovery in the paper industry, stirring power boilers, waste-to-energy applications, and biomass combustion technologies.

A comparison of Table 1 and Table 2, above, shows that the present DPPS allows an increased steam flow to be controlled to a target steam temperature while maintaining the desired outlet pressure.

Under increased flow conditions the DPPS design provides ability to re-use existing superheater surface without lowering outlet pressure; ability to reach full steam temperature with less heating surface than prior art designs; and ability to control pressure drop across each steam path.

Alternative methods for processing an increased flow condition include allowing outlet pressure to decrease and removing the existing superheater (tubes, headers, roof seals, etc.) and installing new surface with additional parallel flow paths.

In another alternative, all or a portion of capacity increases may be derived from increases in operating temperature. In these embodiments the method described herein may further be used to maintain a desired pressure drop while maintaining a desired superheater outlet temperature. While specific embodiments and/or details of the invention have been shown and described above to illustrate the application of the principles of the invention, it is understood that this invention may be embodied as more fully described in the claims, or as otherwise known by those skilled in the art, including any and all equivalents, without departing from such principles.

We claim:
1. A dual-path parallel superheater, comprising:
   a. a drum, said drum adapted to deliver steam;
   b. a steam receiving apparatus opposite said drum;
   c. a first surface adapted to receive steam from said drum, to provide a first path for superheating said steam and to deliver steam in a direction of a steam receiving apparatus;
   d. a second surface adapted to receive steam from said drum, to provide a second path for superheating steam and to deliver steam in said direction of a steam receiving apparatus, said second path located at a position substantially parallel to said first path;
   wherein each of said first path and said second path has a spray attenuator at an interstage location thereof; and
   wherein said first surface and said second surface are arranged such that steam delivered from said first path and steam delivered from said second path combine so that a single quantity of steam is delivered in said direction of said steam receiving apparatus.
2. A dual-path parallel superheater, comprising:
   a. a drum, said drum adapted to deliver steam;
   b. a steam receiving apparatus opposite said drum;
   c. a first surface adapted to receive steam from said drum, to provide a first path for superheating said steam and to deliver steam in a direction of said steam receiving apparatus;
   d. a second surface adapted to receive steam from said drum, to provide a second path for superheating steam and to deliver steam in said direction of said steam receiving apparatus;
apparatus, said second path located at a position substantially parallel to said first path; and
wherein said first surface and said second surface are arranged such that steam delivered from said first path and steam delivered from said second path combine so that a single quantity of steam is delivered in said direction of said steam receiving apparatus.

3. The superheater according to claim 2, further comprising a spray attenuator along said first path.

4. The superheater according to claim 2, further comprising a spray attenuator along said second path.

5. A dual-path parallel superheater, comprising:
   a drum, adapted to deliver steam;
   a first surface adapted to receive steam from said drum and to provide a first path for superheating steam;
   a second surface adapted to receive steam from said drum and to provide a second path for superheating steam, said second path located at a position parallel to said first path;
   wherein each of said first path and said second path has a spray attenuator at an interstage location thereof; and
   wherein steam delivered from said first path and steam delivered from said second path combine to form a single quantity of steam.

6. A dual-path parallel superheater, comprising:
   a drum, adapted to deliver steam;
   a first surface adapted to receive steam from said drum and to provide a first path for superheating steam;
   a second surface adapted to receive steam from said drum and to provide a second path for superheating steam, said second path located at a position parallel to said first path; and
   wherein steam delivered from said first path and steam delivered from said second path combine to form a single quantity of steam.

7. The superheater according to claim 6, further comprising a spray attenuator along said first path.

8. The superheater according to claim 6, further comprising a spray attenuator along said second path.

9. A method of superheating steam, comprising:
   providing a drum;
   providing a steam receiving apparatus;
   providing a first surface defining a first path adapted for receiving and delivering steam;
   providing a second surface defining a second path adapted for receiving and delivering steam, said second path arranged substantially parallel to said first path;
   delivering a first quantity of steam from said first path in the direction of said steam receiving apparatus;
   delivering said second quantity of steam from said second path in the direction of said steam receiving apparatus; wherein said first quantity of steam is delivered from said first path such that it mixes with said steam from said second path, such that said first quantity of steam delivered from said first path and said second quantity of steam delivered from said second path recombine to form a single third quantity for delivery to said steam receiving apparatus.

10. The method of claim 9, further comprising the step of providing said first path with a spray attenuator at an interstage location thereof.

11. The method of claim 9, further comprising the step of providing said second path with a spray attenuator at an interstage location thereof.

12. A method of superheating steam, comprising:
   providing a drum;
   providing a first surface defining a first path adapted for receiving and delivering steam;
   providing a second surface defining a second path adapted for receiving and delivering steam, the second path arranged substantially parallel to said first path;
   delivering a first quantity of steam from said drum in the direction of said first path;
   delivering a second quantity of steam from said drum in the direction of said second path;
   superheating said first quantity of steam along said first path;
   superheating said second quantity of steam along said second path;
   delivering said first quantity of steam from said first path in the direction of said steam receiving apparatus;
   delivering said second quantity of steam from said second path in the direction of said steam receiving apparatus; wherein said first quantity of steam is delivered from said first path such that it mixes with said steam from said second path, such that said first quantity of steam delivered from said first path and said second quantity of steam delivered from said second path recombine to form a single third quantity for delivery to said steam receiving apparatus.

13. The method of claim 12, further comprising the step of providing a steam receiving apparatus opposite said drum.

14. The method of claim 13, further comprising the step of delivering said first quantity of steam from said first path and said second quantity of steam from said second path in a direction of said steam receiving apparatus.

15. The method of claim 14, wherein said steam from said first path and said steam from said second path are mixed in such manner as to combine to form a single quantity of steam for delivery to said steam receiving apparatus.

16. The method of claim 12, said first path is provided with a spray attenuator at an interstage location thereof.

17. The method of claim 12, said second path is provided with a spray attenuator at an interstage location thereof.